GOTARC *Series* B, No. 10 Etnologiska studier 44

Prehistoric Stonework in the Peruvian Andes

A Case Study at Ollantaytambo

Lisbet Bengtsson

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Bengtsson, Lisbet. 1998. *Prehistoric Stonework in the Peruvian Andes. A Case Study at Ollantaytambo.*
GOTARC Series B (ISSN 0282-6860) No. 10
Etnologiska studier (ISSN 0374-7530) 44. Göteborg, xvi + 220 pp, 76 Figures, 4 Tables, 1 Appendix.
ISBN 91-85952-76-1.

This book analyses some aspects of the fine masonry attributed to the inkas. It is elaborated as a case study and deals with stonework at Ollantaytambo in southern Peru. Although many works on inka society include references to the fine masonry, very few are focussed on its production.

The objective is to study the labour process before the erection of the so-called Sun Temple at Ollantaytambo. Questions raised include how and when the stonework was done, by whom it was executed and why.

The technical aspects dealt with include raw material, splitting, rough preparation, transportation, and fine preparation. Most of the fieldwork was done by surveying, but minor excavations were also made at certain test-points.

The societal and cultural aspects involve the dating of the labour process and include ^{14}C datings of materials from the investigation area. To understand the social setting in which the stonework was done, both written sources and field evidence are used. Conclusions about the labour organization are drawn on the basis of field evidence. There is also a discussion of labour security and health care. The possible motives for building the temple of fine masonry at Ollantaytambo are discussed.

Keywords: technology, labour organization, inka, masonry, Ollantaytambo, Peru

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English revised by
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Photographs by
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To the Indians of today, who believe that they
are entitled to exist in their ovun right, and
to all who have respect for these people,
this book is dedicated

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FOREWORD

In the Andes of Peru, many people live in a harsh climate and under sometimes barely supportable conditions. To this day, the Indians are looked upon as stupid, lazy and incorrigible by many whites, occidentalized mestizos and even by some Indians. In contrast, their ancestors are often glorified because of society's need to form and strengthen a national feeling: a glorious past must mean a glorious future for Peru as a nation.

Knowledge of the past is crucial for an understanding of today. Few spokesmen seem to consider that the Indians of today are the heirs of the past civilizations. The past is not glorious, though; people lived in whatever way they could, sometimes under better conditions, sometimes under worse. I hope to make a moment of that past more discernible and thus more present.

Living in the Cusco region of Peru between 1974 and 1977, I was struck by the quantity and variety of the visible, prehistoric remains. At the same time, the knowledge of the past seemed fragmentary. In Cusco, the one set of remains that is generally shown to visitors is the so-called inka-walls, walls of fine masonry with extremely well-fitted blocks of stone, presumably dating from late inka times. It was natural to ask questions about their background and construction, but the answers I received were more often than not unsatisfactory and sometimes even obviously erroneous. It seemed to me to be a sufficiently challenging task to be worth spending years of my life on. When I returned to Sweden in 1977, the stones and the magnificent landscape of which they form part kept appearing in my mind and even disturbed my dreams over the following years. This incited me to prepare to carry out research on these walls. Choosing between engineering, architecture and archaeology, I found archaeology to be the most appropriate field. One reason was that, since the remains are prehistoric, the archaeologists can be regarded as being especially responsible for them. Another reason was that it is only in archaeology that part of the work consists in looking *into* the ground, something which I thought might be crucial for an understanding of the building of the walls.

The present work was originally submitted as a doctoral dissertation to the Department of Archaeology at Göteborg University, in June of

1998 (Bengtsson 1998). Fieldwork was carried out in the years 1983, 1985, 1986, and 1989. It was concentrated in the district of Ollantaytambo, which presents exceptional opportunities for studying the construction of fine masonry. I had spent two years in the village in the mid-1970s, and my son had been born there. These conditions, of course, affected my work. Earlier studies in social anthropology had also left their mark, as well as experiences during the breaks in my efforts on the Peruvian scene, breaks when I was a member of a Swedish-Argentinian research project in the province of Tucumán in north-western Argentina, when I taught at the universities of Göteborg and Oslo, and when I worked as a rescue archaeologist in Sweden.

ACKNOWLEDGEMENTS

A NUMBER OF PERSONS, institutions and foundations made this study possible. I wish to extend my special thanks to the Instituto Nacional de Cultura (INC), Departamental Cusco, Peru, for their permissions to let me work in their country; to the Swedish Institute for their great financial support; to the Accelerator Laboratory at Tucson (Professor A. J. T. Jull), Arizona; to the Swedish Council for Research in the Humanities and Social Sciences through Ängströmlaboratoriet, Uppsala, for their support with ^{14}C analyses; and to Göteborg University, who gave me several grants from different funds.

Grants were also given by Helge Ax:son Johnsons Stiftelse, the Royal Society of Arts and Sciences in Gothenburg, Wilhelm och Martina Lundgrens Vetenskapsfond, Kungliga och Hvitfeldtska Stipendieinrättningen, Stiftelsen Lars Hiertas Minne, and Kjellbergska Flickskolans Donationer. Part of the field equipment was lent by the Department of Archaeology, Göteborg University, and Fjällräven AB gave us discounts on camping equipment. The Department of Conservation, Göteborg University, let me use their photographic laboratory, and the Department of Physical Geography, Göteborg University, their reproduction equipment. The staff at the Department of Anthropology at the University of Illinois at Urbana-Champaign received me very well and helped me in several ways during my stays there in 1992 and 1993. The Department of Archaeological Investigations at the National Heritage Board in Sweden financially supported my work in preparing the manuscript.

In the fieldwork, several persons from Scandinavia participated, most of whom were archaeology students at Göteborg University. They paid their travel expenses themselves and stayed between one week and two and a half months. They included Sven Ahlgren, who is also a geologist and has an appendix included in this thesis, Eva S. Andersson, Åsa Bengtsson, Linda Burénius, Solveig Dybvik, Konstanze Hillebrand, Lars Hultin, Karin Jeppsson, Nils Johansson, Martin Kilbo, Mats Larsson, Peter Lundgren, Turid Venstøp, and Olavi Widerström. Piet van Ipenburg from the Netherlands helped us to survey the Vilcanota river. From the village of Ollantaytambo, I was assisted by Mario Huamán, Leoncio "Walter" Monteagudo Carasas, Leoncio's cousin Mario and

Tadeo Gibaja López. Leoncio worked with us most of the time and was always ready to impart local knowledge and concepts.

At the INC office in Cusco, I wish to thank Freddy Escobar, Percy Ardiles Nieves, Rubén Orellana Neira; the anthropologists Percy Bonnet, Arminda Gibaja de Valencia, Justo Torres Montesinos, Alfredo Valencia Zegarra and Wilfredo Yépez Valdéz and the anthropology student Anselmo Nieblas Huillca; Dr. Oscar Núñez del Prado Castro, Fermín Díaz Angulo and Danilo Pallardel Moscoso; the architects Gustavo Manrique Villalobos, Roberto Samanez Argumedo and Manuel Casas Sáenz; Wilbert San Román Luna; and the physicist and chemist Carlos Cano Núñez. Hugo Ludeña Restaure at the INC office in Lima also encouraged me in my work.

From the Universidad Nacional San Antonio Abad in Cusco, I wish to thank Drs. Luis Barreda Murillo (archaeology), Carlos Kalafatovich (geology), and César Vargas Calderón (botany). Rosa Alicia Quirita H., an anthropology student, showed patience in measuring grave-houses and in recording ceramic data.

Others with whom I had discussions or who in other ways contributed to the work are Dr. Sara Lunt, Oxford, who studied ceramics from our excavations; dear Rosa del Alamo S. and the late Robert Randall, both in Ollantaytambo; Dr. Jean-Pierre Protzen, of the University of California, Berkeley; Ari Zighelboim at the University of Illinois at Urbana-Champaign; Gillian Hey, Oxford; and Colin McEwan at the British Museum. Dr. Lars Arvidsson helped me with the identification of lichens, and Björn Broo with osteological identifications; both were at the time at the Museum of Natural History in Gothenburg. Stefan Klingberg made the rock analyses, and Inger Liebig, assisted by Lena Karlsson, made the grain-fraction analyses; all three were at the time at the Department of Geology, Göteborg University/Chalmers University of Technology. Dr. Krister Svedhage at the same department initially suggested the possibility of using lichenometry for dating in my work. Ulf Strucke at the National Heritage Board in Sweden helped me to evaluate the radiocarbon datings. Dr. Ann Kendall, of the Institute of Archaeology in London, let me look into the organization of the Cusichaca Project. Dr.

Peter Møller Jørgensen, director at the Herbario QCA of the Pontificia Universidad Católica del Ecuador in Quito, and Katya Romoleroux at the same institution, provided *qeuña* tree samples, and Professor Elisabeth Wheeler at the School of Forest Resources, North Carolina State University at Raleigh, U.S.A., made various computer searches to match wood samples from Ollantaytambo with trees registered in their data-base. Dr. Ulf Molau, of the Section of Systematic Botany at Göteborg University, was helpful in this connection. I want to extend my special gratitude to Professor R. Tom Zuidema for his never-failing enthusiasm. Both Tom Zuidema and Ian Farrington read the whole manuscript at one stage and made valuable comments. Ramiro Matos Mendieta, too, read the manuscript and was very supportive. My thanks go also to my relatives in Sweden, who helped by taking care of my son Gabriel during the 1983 and 1986 field seasons. When Gabriel was with us in the field, he saw to it that we always stayed alert.

My former companion, the late Blas Manrique Naharro, inspired me to ask questions about the fine masonry in the Andes. Professor Arne B. Johansen was my initial tutor in the Department of Archaeology at Göteborg University. Associate Professor Lise Bender Jørgensen was of invaluable help in concluding the project. The original drawings were turned into artwork by Cecilia Häggström. Two of the figures were re-drawn from Hyslop (1990), with permission from the University of Texas Press. My photographic negatives were turned into presentable copies by Eva S. Andersson. Chia Nohlberg-Löfqvist and Hans Nohlberg made the layout of the book.

I INTRODUCTION

Only a minute portion of the sum total of human knowledge has been written down. Most of our knowledge as humans has been, and still is, transmitted through action, observation, imitation, and non-verbal attitudes (see Molander 1996). The historical sources are far from always reliable or satisfactory as regards prehistoric conditions, knowledge, procedures or chronology. I regard archaeology as a discipline well suited to study labour processes and related issues. Hitherto, the potential of the discipline has been explored only to a minor degree, as regards investigating how, when, by whom and why the fine masonry of the Andes was built. I propose to mainly use field data in my study. Although I do use written material from the time after the European conquest of the region and analyses based on such material to understand the stonework, I merely wish to use such data as a reference when studying the physical evidence.

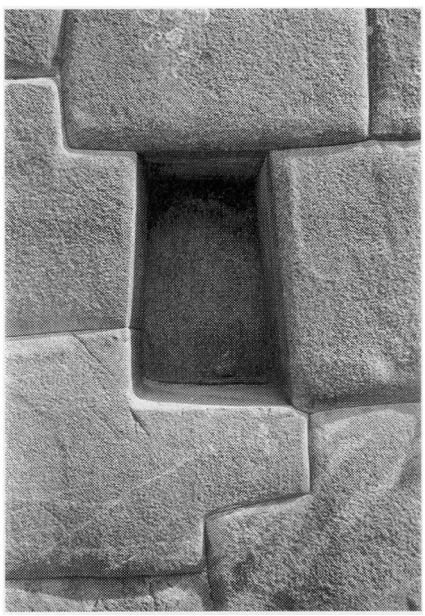
Fine masonry

There are remains of fine masonry over a vast territory within the frontiers of the ancient inka empire. They are found in the coastal desert, in the mountains of the Andes chain, and on the fringe of the rainforest on the eastern slopes of the mountain chain. They are present in Peru, with a concentration in Cusco and its vicinity, and in Ecuador. In the south, they extend as far as the Lake Titikaka basin, but I have found no sources that describe such stonework beyond and to the south of that region, although the empire did reach further south. A somewhat similar case is reported for another type of remains attributed to the inkas, namely carved rocks, which do not extend over the whole territory. Such rocks have been confirmed as far south as central Bolivia but not beyond (van de Guchte 1990: Illus. 2; Hyslop 1990:125).[1]

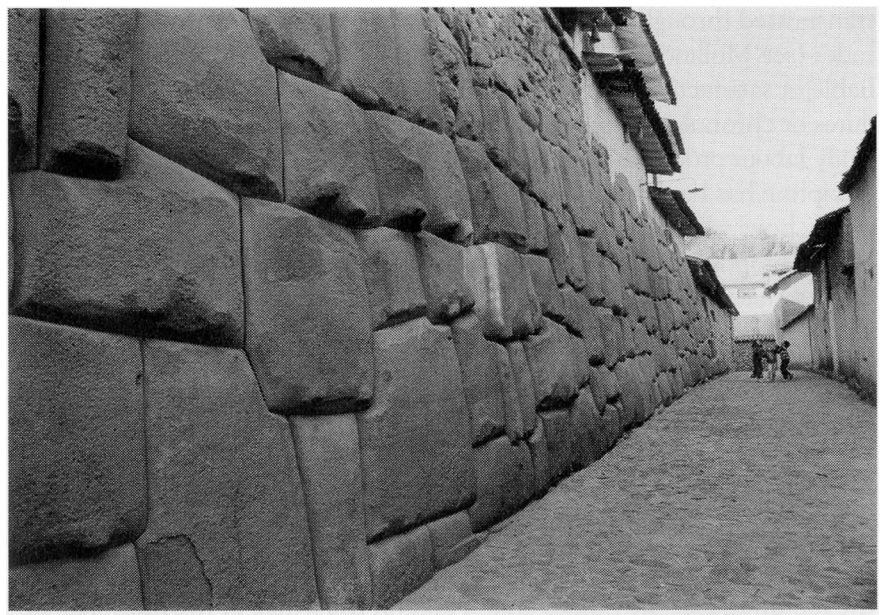
The originality of the constructions of fine masonry does not lie in their layout but in the precision and care with which the stones were prepared and put together. The walls vary in the sizes of the stone blocks employed, in the kinds of rock, in the shapes of individual blocks, and in the pattern in which they are put together. The sizes of the blocks vary from about 20 cm to several metres. Their shapes vary from rectangular

to irregular and polygonal, and they are usually laid either in horizontal rows, in irregular but more or less horizontal rows or in a cellular pattern. The outer surfaces of the blocks are usually curved but may also be flat (Figure 1). The rocks employed include andesite, diorite, granite, sandstone and limestone; other rocks may also have been utilized. The walls were erected for different kinds of constructions. In many cases, they form houses and yards. In other cases, they form terrace walls, other retaining walls, and platform walls. Their different uses are not satisfactorily known, but this is not an issue in this book.

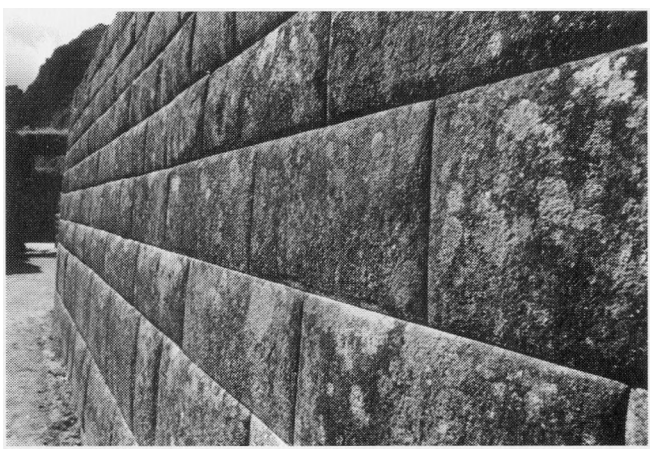
Figure 1 *a-d.*
Examples of fine masonry.



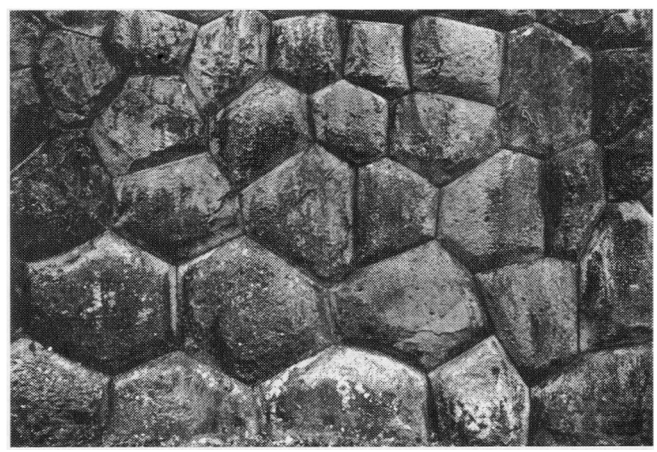
(*a*) Ollantaytambo



(*b*) Cusco



(*c*) Machu Picchu



(*d*) Tarawasi

Inkas and Inkas

The term "inka" has been and is used with different meanings. It is employed to define a ruling class or nobility and a period. In those instances, I shall write "inka" in lower-case letters. When saying "inka bridge" or "built by the inkas", I mean that the bridge, or whatever is in question, was, as far as we know, initiated by or built under the supervision of representatives of the administration in Cusco. When saying "in inka times", I refer to the late prehistoric period, although insufficiently known, during which the inkas exerted some kind of control from Cusco over neighbouring areas and beyond. The "inkas" included not only those groups in Cusco who were related by blood to the Inka rulers but also those groups from the region who had been given a special status, also called "inkas-by-privilege" (Rowe 1946:260–261; Zuidema 1990:68, 76). In the literature, the term (written as "Inca" or "Inka") has sometimes been used in the sense of "people" or ethnic group, but it should be noted that that was not a meaning used within the inka empire itself, as far as we know. Rather, the term "inka" was a male epithet in inka times.

When I write "Inka" with an initial capital letter, I refer to the ruler, the king. In those cases, I shall endeavour to avoid any confusion by adding the epithet "ruler".

The inka empire

The inka empire was administered from the capital, Cusco. The Inka rulers governed an increasing territory, expanding from the Cusco Valley and reaching what is now Ecuador, north-western Argentina and northern-central Chile, including major parts of Peru and about half of Bolivia (Figure 2).

The last ruler crowned was Waskar, who was killed on the orders of his half-brother Atawalpa in A.D. 1532. Earlier that year, Atawalpa had become a prisoner of the Spaniards. By A.D. 1534, Atawalpa, who had competed for the throne with Waskar, was himself dead, and the Spaniards had founded a Spanish municipality in Cusco (Hemming 1983: 501–502). While the end of the empire can be dated to A.D. 1532 from the written sources, its beginning is much in the shadow. Most authors consider that the expansion of the state lasted for about a hundred years, from Pachakuti Inka Yupanki's reign onwards. This view is to a high degree a consequence of an article by John Rowe (1945), who established a chronology for the reigns from Pachakuti Inka Yupanki onwards, which he based on an account written by Cabello de Balboa in 1586. Rowe not only placed the rulers in chronological order but also gave the approximate dates for their respective reigns and prepared a map showing the expansion of the empire under each ruler. The scheme presented by

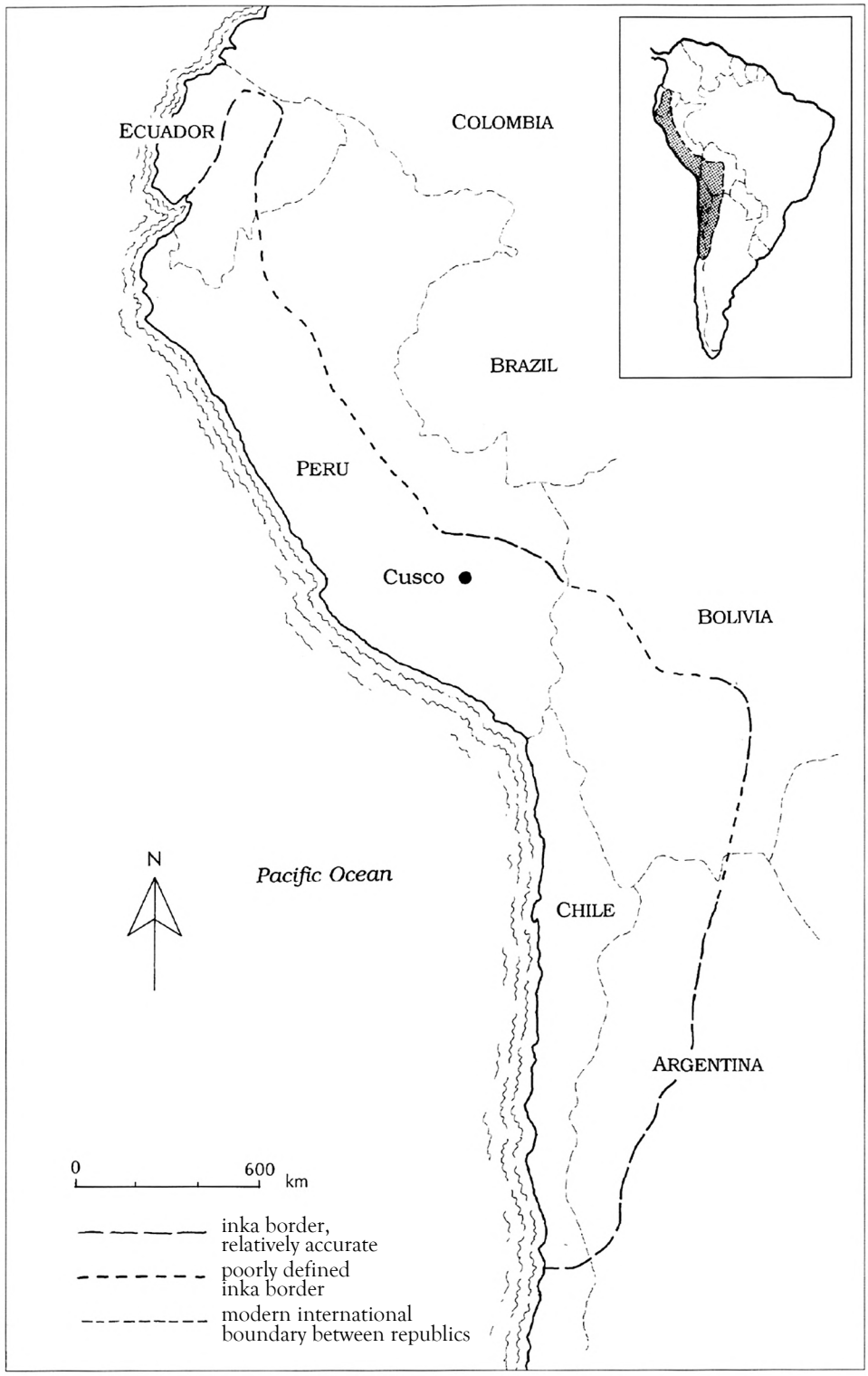


Figure 2.
The expansion of the inka empire.
Redrawn from Hyslop 1990:2.

Rowe (1944, 1945, 1946) has had a great impact on works on inka society ever since, due, I believe, in part to the effect of his visualizing in a simple way what seem to have been complex phenomena (see, for example, Adamska & Michczyński 1996:47). In doing so, he overestimated the historicity of the information given by Cabello de Balboa, who did not have first-hand information on the inka empire. As Åke Wedin has argued, one reason for attributing most conquests to Pachakuti and his descendant Tupa Inka Yupanki may well have been that, by the time Cabello de Balboa made his inquiries, the memory of the deeds of earlier rulers had faded (Wedin 1963:14–15).

The lengths of the rulers' reigns differ considerably in the written sources. For example, it can be inferred from Sarmiento (1988:63 [1572]) that he regards A.D. 565 as the year when the first ruler, Manco Capac, arrived at Cusco and established himself there; Cabello Balboa (in Wedin 1963:32) gives the year A.D. 945 for Manco Capac's ascent of the throne. Rowe, on the other hand, suggests that the beginning of the inka dynasty can be dated to around A.D. 1200 (1946:203). The number and the internal order of the rulers are fairly consistent in the different ancient sources, but Tom Zuidema has argued that one more ruler than Tupa Inka Yupanki should probably be inserted between Pachakuti Inka Yupanki and Wayna Qhapaq (1990:46–48, 88) (Table 1).

12.	Huascar Inca	(also called Tupac Cusi Hualpa and Titu Cusi Hualpa Inti Illapa)
11.	Huayna Capac	(also called Titu Cusi Hualpa)
10.	Topac Inca Yupanqui	(also called Inca Capac)
9.	Pachacuti Inca Yupanqui	(also called Cusi and Inca Yupanqui)
8.	Inca Viracocha	(also called Hatun Tupac Inca)
7.	Yahuar-Huacca Inca Yupanqui	(also called Titu Cusi Hualpa)
6.	Inca Rocca Inca	
5.	Capac Yupanqui	
4.	Mayta Capac	
3.	Lloqui Yupanqui	
2.	Sinchi Rocca	
1.	Manco Capac	

Table 1.
The list of Inka rulers, as given by Sarmiento (1988 [1572]). Sarmiento's spelling is maintained. The most recent ruler is placed at the top.

The chronological framework

Three prehistoric periods, for which there is evidence of widespread stylistic influences, are recognized in Peru. They are called "horizons", in contrast to the periods without such widespread influences, and are used as chronological markers. The last one, the Late Horizon, is taken to represent the expansion of the inka state (Table 2).

Table 2.
Chronological chart.

Time scale[a]	Relative chronology[b]	Widespread styles	Ceramic styles in the Cusco region[c]
A.D. 1532			
	Late Horizon	Inka	Cusco inka Provincial inka Killke
A.D. 1400			
	Late Intermediate Period		Cusco inka Provincial inka Killke-related Killke Lucre
A.D. 1000			
	Middle Horizon	Wari, Tiwanaku	Wari Ocros Lucre Qotakalli
A.D. 600			
	Early Intermediate Period		Pacallamocco Chanapata-related
0			
	Early Horizon	Chavín	Chanapata Pacallamocco
B.C. 600			
	Marcavalle		

[a] Bauer 1992:41; Burger 1992:231.
[b] Rowe 1970.
[c] Barreda 1982; Heffernan 1989:1:86–110; Kendall 1992:30, 76–77, 91; Lunt in Kendall 1992:29.

Owing to their definition, the horizons do not appear simultaneously in different parts of the spheres of influence. As for the inka state, we do not know enough about its development to set its beginning in time with any precision. It is clear that the presence of inka ceramics at a site does not necessarily imply that the site was already incorporated into the state (Lunt in Kendall 1992:29; Pärssinen & Siiriäinen 1997). The correlation between styles and time in Table 2 should thus be seen as approximate.

[1] However, three small, carved rocks in Sierra de Arica in northern Chile have been reported by Hans Niemeyer (Flora Vilches, personal communication, Lampeter, 1998), and they apparently show similarities to one reported from Antofagasta de la Sierra in north-western Argentina. The rock in Antofagasta de la Sierra does show similarities to the carved rocks of the Cusco region but also differences (see Instituto Nacional de Antropología ... 1997:29). The links between these rocks and those of the Cusco region need further study.

1.1 Aim of study and definition of subject

The aim of this book is to study how, when, by whom, and why the fine masonry of the Andes was built. It is elaborated as a case study.

Selection of investigation area

The place chosen for study is Ollantaytambo in the Cusco department of Peru (Figure 3). The remains at Ollantaytambo fulfil the requirements for the study of various aspects of the stonework. The quarries at Kachiqhata in the Ollantaytambo district are very rich in evidence of the production of building blocks for fine masonry, and these quarries show minimal disturbance by later activities. Other quarries used for the extraction of building blocks for fine masonry, such as those at Waqqoto and Rumiqolqa—about 15 km and 35 km south-east of Cusco respectively—are still being exploited, and they are therefore less convenient for study.

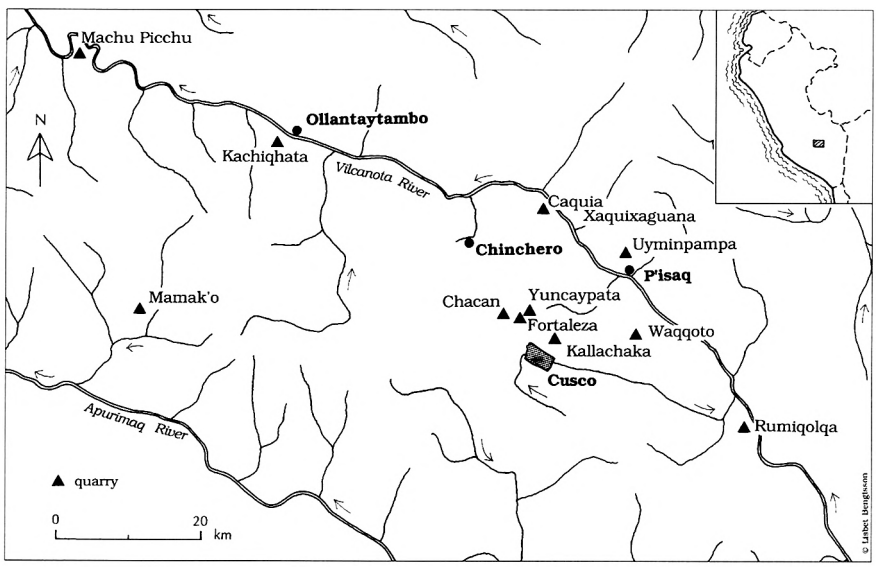


Figure 3.
Location of Ollantaytambo. The quarries marked were quite certainly exploited in inka times.

Another definite advantage of Ollantaytambo is that prepared stone blocks can be observed on the ground between the quarries at Kachiqhata and the building site in the temple area by the village of Ollantaytambo, making it possible to study aspects of their transportation on the basis of field observations. The sizes of the blocks seemed to guarantee their visibility above ground.

Yet another advantage of Ollantaytambo is that not all the constructions in the temple area were finished. This facilitates the study of the labour process.

In addition, Ollantaytambo seemed more suitable than other places with fine masonry for dating purposes. The dating of stone walls is a tricky matter, since the use of a space may not have been contemporaneous with the construction of a wall within that space. In the case of Ollantaytambo, any organic or other cultural material underneath blocks in transport would constitute a good basis for an age determination. A prerequisite for such a determination is that the blocks are heavy enough to have been left *in situ*, something which seemed to be the case at Ollantaytambo.

The point of departure is the front wall of the so-called Sun Temple at Ollantaytambo (Figure 4). The construction of the temple itself was never finished, and stone blocks lie scattered over the building site (Figure 5). The focus in the present study is on the quarries at Kachiqhata, where the stone blocks were extracted for the temple edifice, as well as for other constructions, and on the route of transportation for the building material from Kachiqhata to the temple area. This means that the study deals with topics related to phases before the phase of erection. This procedure emphasizes the input of care and labour on the part of the builders into the task itself rather than in the result, impressive as it may be.

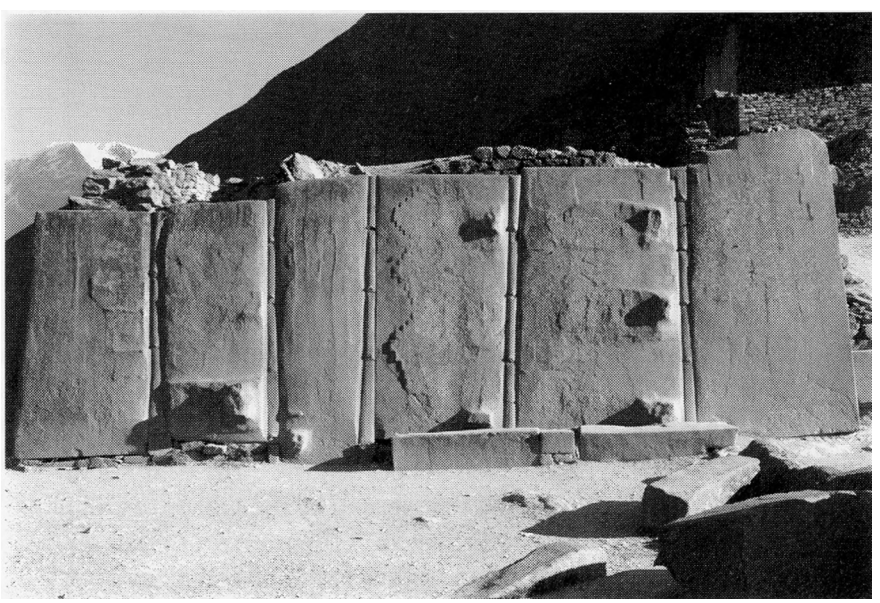
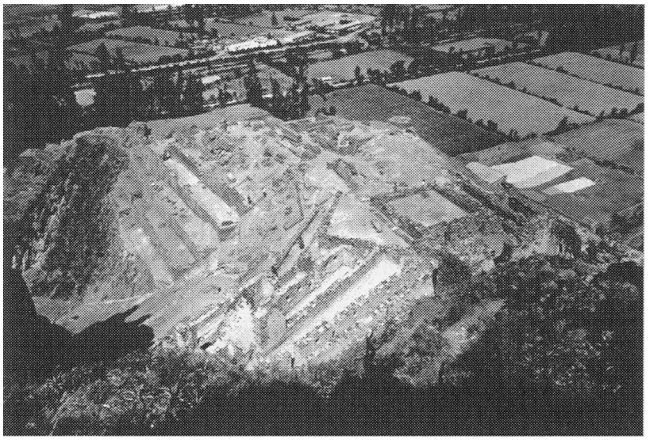


Figure 4.
The front wall of the so-called Sun Temple at Ollantaytambo.



(*a*)

(*b*)

Figure 5 *a-b*.
The temple area, Ollantaytambo. The construction was never finished, and building blocks lie scattered over the surface. A few blocks are placed on narrow platforms and were probably being prepared when the work ceased. Facing SSE.

How

As regards how the masonry was built, I look for vestiges of the tools used for the preparation of blocks and for any installations made for the handling and transportation. I am also concerned with any evidence of sequencing in the work. This is at the same time related to the issue of labour organization. Questions I seek to answer in that respect deal with the grouping of labourers and the degree of specialization.

If we consider that the different operations in the stonework were crafts that were learned by imitation and direct training rather than through verbal information, it seems appropriate to assume that much of the knowledge that was gained among the stoneworkers is actually still there to be studied in the form of vestiges that we can observe.

When

The term "fine masonry" is used in this study for the remains of prehistoric stone constructions of a specific kind. The remains, often called "inka-walls", are commonly used as a sign or proof of inka presence in an area. As the dating of stone constructions by scientific means is awkward, the fine masonry is usually dated by reference to the historical sources and by correlating that information with cultural material, especially pottery, in the ground. In this study, I am rather concerned with dating the stonework itself. I am also concerned with dating the use of the inner temple area at Ollantaytambo. With these objectives in mind, I use radiocarbon analysis, ceramic analysis, and to some extent field observations of relative age.

By whom

To decide who executed specific tasks is difficult when dealing with prehistoric remains. We cannot know exactly what segments of the society

were involved in the stonework, nor can we know exactly from where they came, how they came to be involved or what tasks they were set to work on. If we are lucky, we can infer from the cultural material whether the work force was mainly local or from other regions. The written sources from the colonial era can be an aid in creating an image of the people involved. By comparing the information in the written sources with my interpretations based on physical evidence, I hope to expand our knowledge of who may have been involved in the stonework at Ollantaytambo.

Why

An even more complicated question is why so much effort was put into creating the constructions of fine masonry. The efforts far exceeded what can be explained by primary needs. Over time, I have become increasingly interested in the possibilities of studying mental processes and concepts on the basis of physical remains. Again, the written sources from colonial times are of help in studying inka times, and ethnographic material is also of help.

1.2 Previous research and present state of knowledge

It is today generally acknowledged that the finely built walls typical of Cusco and its surroundings and spread over a vast territory of the Andes were built by the inka society. The evidence is to be found in the historical sources, where there are references to buildings and building complexes constructed by the inkas. Sometimes, the writers even refer the construction to a specific ruler.

The literature on the inkas is vast. John Hyslop (1984:344) reported more than six hundred titles with relevance to his project at the time of his writing. The fine masonry has received attention in many of these works, but very few of them are focussed on the *production* of the masonry.

The literature in which the fine masonry is dealt with or mentioned can be divided into three categories, namely the ancient, historical sources of the 16th and 17th centuries, the travel accounts of the 19th century, and the statements and research of our own century. All three have their advantages and disadvantages. Together, they form the basis of the present state of our knowledge.

Ancient, historical sources

Much of the information on the construction of fine masonry in the historical sources is based on oral tradition. In a few cases, data were kept on *khipus*, the knotted strings used as mnemonic devices. To my knowledge, no information was passed on to the chroniclers or to representatives of the colonial administration by people who had been directly involved in the stonework. In general, the earlier chronicles are more reliable as regards inka society than the later ones (Wedin 1966). The chronicles written by Betanzos (1987 [1551]) and Cieza de León (1985 [1554], 1986 [1553]) are two of these early works, and I shall use them as a starting-point.

Cusco

According to Betanzos (1987:75 [1551 :Ch. 16]), Inka Yupanki (also called Pachakuti Inka Yupanki) went, together with some of the nobles of Cusco, all round Cusco and up to about 28 km away from it to look for and inspect any mountains and places where stones could be extracted for building purposes. There is no mention by Betanzos of any need for specialists in this task. They found that at Saluoma there were great amounts of stone and very large quarries. Saluoma must correspond to

Oma and Salu, which he mentions elsewhere (1987:170 [1551 :Ch. 37]). Oma corresponds to the present-day San Jerónimo, and Salu is called Sallaq. In inka times, they were organizationally related. Betanzos' way of putting it makes it seem that the source of stone was not known to the Inka ruler or to the nobles, although it was already known and exploited by others. For the transportation of the blocks, the Inka ruler and the nobles ordered a large number of thick ropes to be made from the nerves and hides of camelid. Inka Yupanki (Pachakuti Inka Yupanki) made the layout of the town, and he had clay models (*figuras de barro*) shaped in the way he wanted the town to be fashioned and built (Betanzos 1987:76 [1551:Ch. 16]).

Cieza says that some provinces were ordered to provide so many thousand Indians to be stationed in Cusco to build the public edifices there, as well as the buildings of the kings (1985:52 [1554:Ch. 18]). The people who were to work on the edifices came from the provinces at certain times of the year (1986:259 [1553:Ch. 93]).

Qorikancha in Cusco

Betanzos says that building material for the House of the Sun (also called Qorikancha) in Cusco was brought from a quarry near the village of Salu almost 25 km away. The building was measured and laid out by the Inka ruler himself, using a cord. The ruler at the time was Inka Yupanki (Pachakuti Inka Yupanki) (Betanzos 1987:50 [1551:Ch. 11]). The Inka also measured the stones in the quarry that were going to be used. The building blocks were taken to the construction site by the inhabitants of the villages that lay near the quarry, and they also brought whatever else was needed for the construction. The same people then built the House. The construction was supervised by the Inka ruler and by the lords of Cusco (Betanzos 1987:50 [1551:Ch. 11]). The construction is said to have been rapid, since everything needed was at hand at the site (Betanzos 1987:50 [1551:Ch. 11]). The motive was to build a temple dedicated to the Sun, and the stones of the building were revered (Betanzos 1987:52 [1551:Ch. 11]).

Betanzos does not mention what techniques were used to extract, transport or prepare the blocks or how the walls were erected. No mention is made of how many workers were involved, how they were organized internally, what tools or other means they used or how long the work took.

When Cieza speaks about Qorikancha, he says that no mortar made of soil or lime was used, but instead the pitch (*betún*) that they usually employed for their buildings. The Qorikancha temple is "as old as the town of Cusco itself", says Cieza, but was enriched by Inka Yupanki (Pachakuti Inka Yupanki), a son of Wiraqocha Inka (1985:79–80 [1554:Ch. 27]).

Saqsaywaman above Cusco

The construction of the most majestic of the building complexes of fine masonry, Saqsaywaman on the heights above Cusco, is attributed by Betanzos to the reign of Tupa Inka Yupanki (1987:169 [1551 :Ch. 37]). There are similarities but also differences between that Inka ruler's procedure and the procedure used by the earlier Inka ruler Inka Yupanki (Pachakuti Inka Yupanki) for the rebuilding of Cusco. Tupa Inka Yupanki gathered together not the lords of Cusco but the leaders of the whole country. He furthermore ordered that they should bring with them the best builders from their respective regions. Tupa Inka Yupanki consulted them about his ideas and then himself drew the layout. He also chose the building site himself (Betanzos 1987:170 [1551:Ch. 37]). The plan was then laid out by the master builders and technicians, using cords for measurement, and, if I interpret Betanzos rightly, by drawing (*traza*) the layout on the ground. This was all done under the direct supervision of the Inka ruler. The foundations were then prepared. Stone was brought from the quarries near the villages of Oma, Salu and Guairanga, which were located up to 28 km from Cusco. It took two years to bring and prepare the stones, provide ropes and mortar, and open up and prepare the foundations. After that, the actual construction took place. Most of the time, 10,000 men were occupied in this task. Some got the mortar ready, others prepared the stones, and others again put the stones into place. The majority of the workers were occupied in bringing the stones from the quarries and in putting them into place. Some of the stones could be brought by ten or twenty men carrying them on their backs, but the majority of them were so large that, for one block, five hundred men might be needed and, for another, a thousand. These large blocks were brought by tying them with very thick ropes and dragging (?) them (*a jarro*). In the same way as in his reference to the reconstruction of the town of Cusco, Betanzos says that the ropes were made of the nerves and hides of camelids. These large blocks had also to be prepared. The construction took six years. When it was finished, Tupa Inka Yupanki assembled all the people who had worked on it and gave presents and favours to each and every one of them, according to their rank and capacity *(calidad)*. They were then sent back to their homelands to rest (Betanzos 1987:169–171 [1551:Ch. 37]).

Cieza ascribes the beginning of the construction of Saqsaywaman to the Inka ruler Inka Yupanki (Pachakuti Inka Yupanki). His son, the Inka ruler Tupa Inka (Tupa Inka Yupanki), continued the work, and after him the Inka ruler Wayna Qhapaq and the Inka ruler Waskar. Cieza says that it was ordered that 20,000 men should be brought from certain provinces and that the people there should send them the necessary provisions. If anyone fell ill, he should be replaced by another man and then return to his homeland. No one labourer stayed all the time that the construction

lasted hut only for a limited time, so that, when new labourers came, those on the site left. In this way, the work was not burdensome. Four thousand of the 20,000 men split the stones and extracted them, and 6,000 brought them to the site with the aid of thick ropes of hide and *cabuya* fibre (probably *Furcraea andina*). The remainder worked on opening the ditch and on making the foundations, and some went to cut large forks and beams for the wooden roof. The ditch was opened in the actual bedrock. Inspectors and master builders watched over the work. For general satisfaction, each socio-political grouping (*parcialidad*) made its lodgings separate from the others, close to where the edifice was to be built. Cieza visited the site twice, and he says that, at the time, most of the walls of these houses were still standing. He was amazed at the construction of Saqsaywaman, one reason being that he saw so few tools among the people. The motive for the building was to erect yet another House of the Sun, one which would surpass the one already constructed in Cusco itself (Cieza 1985:147–149 [1554:Ch. 51]). Elsewhere, he states that, when they were working stone, they had done so, and still did, using no other tools than stones (Cieza 1986:300 [1553:Ch. 114]).

Chinchero

A similar procedure reported by Betanzos for Saqsaywaman is reported by him for the construction of the settlement of Chinchero. The Inka ruler (Tupa Inka Yupanki) wished the settlement to be built, and to this end he asked the leaders from the whole country to assemble in Cusco, together with a force of labourers from their respective regions. This force amounted to 20,000 men. When they had come to Cusco, in a certain month of the year, the Inka ruler gave the drawing (*traza*) of the settlement to the lords of Cusco. They went to find a suitable construction site. The drawing was then brought to the spot, about 15 km north-west of Cusco. After the drawing had been seen by the technicians and master builders, they took their cords and measured the settlement. When the layout of the houses and streets had been marked, the Inka ruler ordered that the foundations should be prepared. When this was done, he ordered the lords of Cusco to arrange for the village to be constructed, giving each of them a commission specifying what they were to order to be done or built. The village was built with finely wrought stones and in the way in which they used to build. The settlement took five years to build, and its houses were then given by the Inka ruler Tupa Inka Yupanki to the lords of Cusco. The reason why Tupa Inka Yupanki had to construct the village was to provide housing for some of the growing population of Cusco; to create something by which he would be remembered better; and to provide a place where both he and the lords of Cusco could go for recreation (Betanzos 1987:173 [1551:Ch. 38]).

Nothing is said about the extraction or transportation of blocks, and nothing about the methods used for preparing or fitting the blocks or for erecting the walls. We have indications of a hierarchical labour organization, as well as indications of the energy expended. The construction was initiated by the Inka ruler himself, and the labour was supervised. The supervisors did not necessarily have any knowledge of construction techniques but were engaged by the Inka ruler because they were male nobles. Later on, they were rewarded with the product of their efforts. Lower in the hierarchy were the technicians and the master builders. Great numbers of people participated. The vast majority of the alleged 20,000 workers at Chinchero were most likely *hatun runa* or male, adult and able men paying their tribute in labour. Possibly, they gave their work in the form of *mit'a* (rotational labour)[1] and, in that case, they were probably replaced by others from their home communities during the five years that the construction took. Betanzos does not mention women working on the construction. If Cieza is correct, some of those working in quarries and on preparing stone were not performing their *mit'a* obligation but were actually *mitmaqkuna*, people resettled from other provinces, who in this case were placed there to carry out these specific tasks (Cieza 1985:64 [1554:Ch. 22]).

The information given by the chroniclers, who obtained most of their information in Cusco, the former capital of the empire, can be compared with the information given in administrative documents. During an inspection of the Huallaga (in inka times, called Pillkumayu) Valley in 1549, information kept on knotted strings was transcribed into a protocol by colonial representatives (Murra 1982). The valley is about 600 km to the north-west of Cusco. In inka times the Chupaychu, the main ethnic group in the valley, had had 400 men and women continually stationed in Cusco to build walls. If one of them died, they provided another as replacement. Another 400 allocated to Cusco, or 200 couples, grew food, and—in John Murra's interpretation—did so for the stonemasons as well as for themselves. It is somewhat confusing that the workers were said to remain continually in Cusco, without any reference to their rotation. The fact that they were still recorded as members of the Chupaychu group argues for an interpretation in which their labour input formed part of the *mit'a* obligation also in this case, as Murra (1982:241) has pointed out. The possibility should be considered that people could be classified as, in this case, Chupaychu taxpayers, although in effect they possibly lived for many years away from home. The work in Cusco was maybe looked upon as temporary, while new or expanded construction projects in fact prolonged the people's stay to cover several years. For an evaluation of the term *mit'a*, it is possibly significant that in this case no

rotation is mentioned. The workers seem rather to have been compelled to stay in Cusco, without returning home. The only reason for replacement given is death.

Guillermo Lohman Villena has reportedly suggested that, if similar proportions of the population as recorded for the Chupaychu group were sent to Cusco to build walls from many other groups, there would literally have been no place for them to stand (referred to in Murra 1982:258, n. 10). He therefore expressed scepticism about the figures. Other explanations than exaggerated numbers are possible, one being that other groups did not in general send as large a proportion of their tributary populations to Cusco to build walls. Another explanation, and one which I think should be taken into consideration, is that workers sent to Cusco did not necessarily stay there but were rather used as a pool of workers, from which people could be chosen for construction projects outside the capital, including the Vilcanota Valley, where Ollantaytambo lies. Betanzos' relation of the construction of Chinchero, referred to above, actually suggests that stoneworkers were first assembled in Cusco and from there sent to their stations.

In an account based on interviews during a *visita* (inspection) in 1567, a lord of the Lupaqa polity in the Lake Titikaka basin said that they gave the Inka ruler all the Indians he demanded, to make walls and houses. The Lupaqa lived about 350 km to the south-east of Cusco. At the time, the information was still kept on a *khipu*. The *khipu* was said to be from the last census of the province in inka times (Julien 1982:127). Another lord of the same polity stated that sometimes they gave 100 and at others 200 men and women for service, including builders. It is furthermore said that those who worked for the Inka were fed meat, maize and corn-beer and were well treated (Murra 1982:256). Of the five towns of the Lupaqa (with their respective districts) about which we have information, *all* report that they had labour obligations to build houses and/or walls in Cusco or without specifying where (Julien 1982:Table 5.8). In contrast, other Aymara-speaking groups stated that they were exempt from providing building workers and stonemasons (Espinoza 1969:140).

It appears from the two *khipu* recordings mentioned above that at least some regions of the empire sent considerable numbers of stoneworkers to work for the Inka ruler. In both recordings, the counts of stoneworkers were set on one of the first strings. This would imply a high value, since the more important issues were dealt with early on a *khipu* (Calancha in Murra 1982:258, n. 15). None of the recordings informs us about the technology used to build the fine masonry, nor do they tell us about how the work was organized.

Travellers' accounts

The travel accounts contain valuable remarks on fine masonry, and the authors also tried to systematize their observations. Thus, Wiener (1880) made considerable efforts to categorize different styles of masonry. The accounts are especially useful for the appreciation of the state of preservation of the remains at the time, and for the evaluation of the changes due to destruction or reconstruction that have taken place since then. The works are illustrated with views of sites, plans and details of construction, the earlier ones with engravings, the later ones also with photographs. The remains can therefore be compared with what is to be seen today. Some of the travellers visited Ollantaytambo, which is in focus here (for example, Middendorf 1893–1895:Vol. 3; Squier 1877; Wiener 1880).

Later statements and research

Through the archaeological work carried out at Saqsaywaman, Valcárcel (1934*a*: 185) came to the conclusion that the hypothesis put forward by Clements Markham that such buildings were from a pre-inka megalithic or cyclopean epoch was incorrect. The great majority of the thousands of finds at the site were products of the inka society. The idea of a connection between masonry built with large stones and pre-inka times did, however, continue even after Valcárcel's study (Baudin 1978:97–98). Instead of the different styles being seen as chronological indicators, they are now rather regarded as being related to the intended function of an edifice, to the kind of rock used or to the social group constructing it, or as the result of a combination of those factors (Agurto 1987:162–164; Bennett & Bird 1964:167; Rowe 1946:226; Valcárcel (1934*a*:185). Many of the studies dealing with inka buildings do so from the architectural point of view. They extend from giving detailed information on the sizes of doorways or rooms to comparisons between whole sites (see, for example, Agurto 1980; Alcina 1976; Fejos 1944; Gasparini & Margolies 1980; Hardoy 1968, 1973; Hyslop 1990; Kendall 1974*a*, 1974*b*, 1976*a*; Morris & Thompson 1985; Niles 1987; Rowe 1944). Very few works deal with inka stonework specifically, although many ideas and assumptions about the labour process have been put forward. One of the few dedicated to inka stonework is an unpublished thesis by José Gonzales Corrales (1971). A minor part of his thesis was later published (Gonzales 1982). Gonzales has visited several quarries exploited in inka times (personal communication, Cusco, 1983). Lee Hollowell also studied inka stonework (1987). Although a layman in the field, Hollowell made considerable efforts to understand the stonework, especially that of

Ollantaytambo. He presented a number of hypotheses, and he made some experiments.

To the extent that fieldwork, experiments and laboratory studies have been made, they have contributed to our understanding. Up to now, few researchers have worked with such approaches. The most valuable publications on inka construction so far have been those by the architectural historian Jean-Pierre Protzen (1983, 1985, 1986, 1993). He performed experiments in order to get a better understanding of the use of tools and the way in which blocks of stone were set into a wall. He also documented features photographically and made maps of quarries. His fieldwork in the Ollantaytambo district was carried out intermittently with my own (Bengtsson 1983, 1984, 1985*a*, 1985*b*, 1985*c*, 1986, 1988, 1989, 1991, 1993; Bengtsson & Roslund 1990), and in many ways our studies complement each other.

The following review, which is based on the statements and research of the present century, has two aims. The first is to incorporate the ideas not expressed by either Betanzos or Cieza. The second is to incorporate the results of fieldwork, experiments and laboratory studies. The issues are those that are related to the phases of the labour process that are in focus in this thesis, namely the phases before the erection of the buildings.

Technical aspects

The locations of several quarries used in inka times are known, especially in those the Cusco area (Figure 3). Some of them are still being exploited. Gonzales mentions the limestone quarries near Saqsaywaman and Paqariqtambo, the diorite quarry in the San Blas parish in Cusco, the granite quarries at Machu Picchu and Kachiqhata near Ollantaytambo, the quarries at P'isaq, the andesite quarry of Waqqoto, and the andesite-basalt quarry of Rumiqolqa (1971:42–49). A small quarry in Kallachaka, just north-east of Cusco, which is probably inka was mapped by Susan Niles (1987:93). As far as I understand it, the rock roughly west of, but close to, Cusco was exploited in inka times, but I have not inspected that area (also see Polo 1916:107). Attempts were made to connect building blocks with their sources at Limatambo in the Cusco department (Heffernan 1987). Craig Morris and Donald Thompson mention a fieldstone quarry some kilometres east of the large inka administrative centre of Huánuco Pampa and the transportation route from it to the site (1985:58). Possibly it is the same quarry referred to in connection with an unfinished building of fine masonry (1985:60).

Raw material

Protzen argues that the exploitation of distant quarries, such as those at Rumiqolqa, indicates that a specific rock-type was sought for. Even

within the site of Rumiqolqa, different qualities can be distinguished as between the different quarrying areas, and that is also the case with the Kachiqhata quarries (Protzen 1983:2–3, 1993:157–158, 166–167). One quality that was probably sought for was the splitting properties of the rock. Another quality which seems to have influenced or even determined the choice of raw material was its colour (Bengtsson 1988:3). Little research has been done in this field so far.

Extraction and splitting

Apart from extraction from the bedrock, it has been pointed out that quarrying was also done by extracting boulders from rock-falls or rock-slides (Bengtsson 1988:4; Gonzales 1971:30; Middendorf 1893–1895:3: 523; Outwater 1959:27, 1978:583; Protzen 1983:3, 1985:162), as well as from pits in the ground (Protzen 1983:3). In Harth-terré's view, at Kachiqhata the boulders to be prepared were extracted from a moraine (1965:161).

Some authors have thought that boulders were split by using fire and then applying cold water or alternatively by using chisels and then pieces of wood, which were made to swell by pouring water on them (González *et al.* 1981:56; also see Squier 1877:419). Astete writes that, at Kachiqhata, the stone was broken off the cliff by first heating and then cooling it with water (1952:223). José Gonzales argues that the inkas did not manage to achieve a temperature high enough to split, for example, andesite, by means of heat. In addition, any heating of the stone would change its consistency and make it impossible to prepare (1971:32–33).

The use of chisels is in line with Gonzales' view, but he says that the wedges were made not only of w'ood but also of metal and stone and that bars were used as well (1971:31). The chisels would be used along a natural fissure; then the wedges were inserted by percussion and prying (1971:31). Others have held that the splitting was achieved by first pounding pits into the block's surface (Harth-terré 1965:161) or by pounding a V-shaped notch (Outwater 1959:27, 1978:583). Protzen found no evidence of the use of wedges at Kachiqhata (1993:166). Gonzales reports that, in the quarries of Waqqoto, pieces of the *lloke* shrub have been found inserted in the fissures and also stones serving as wedges. In addition, he describes large stones, which were employed for breaking boulders. They are generally of basaltic andesite, 20–40 cm long and usually intended to be held with two hands (1971:71).

E. Frank proposed that a slit was made in the stone, then the slit was filled with vermiculite or some mineral or metal that expanded on heating, then covered up with metal and heated, to produce a crack in the stone (1980). The method was tested and was rather successful. D. E. Arnold (1983) argued against Frank and instead suggested that different methods were used for different rock-types and for different climatic con-

ditions. One proposal was that, for limestone, the inkas might have used natural organic acids, like urine. As an important method, he suggests the use of freezing water. The repeated pouring of water into cracks made by stone tools, then held there by clay or pitch, would crack the rock because of night frosts at high altitudes. Protzen mentions three ways of splitting boulders at Kachiqhata: by forming a collar around the boulder, by carving away little by little, and by pounding out a channel along a fracture plane (1993:166–169).

There is a popular belief that the inkas sawed stone. It is not clear how that would have been done, but one suggestion put forward was by using a certain reed (Rowe 1946:225). Another view expressed is that they used a cord made of llama hide, which was pulled backwards and forwards together with sand and water (Oscar Núñez del Prado, personal communication, Cusco, 1986). There are traces of tools with a sharp edge being employed on stone (Gonzales 1971:60; Protzen 1993:189).

Preparation

At the inka site of Machu Picchu, hundreds of hammerstones were recovered in excavations in the 1910's, and Hiram Bingham interpreted them as having been used for stonework at the site (1915:207, 1977:215, 1981:227). They showed use-wear marks, and some of them had a shallow depression on each side as a finger grip. They were of a hard, compact rock.

Also Gonzales mentions depressions on some hammerstones (1971: 70). He considers that the blocks were prepared with hammerstones of different shapes and sizes, which were of a harder rock than the block to be prepared. He mentions both hammering of the surface and flaking as methods of reduction. The hammerstones were river cobbles of varying compositions and measured 5–15 cm. Some of them consisted of haematite, others of diorite. In a later stage, stone picks were employed, usually oblong in shape and of a fine-grained structure (Gonzales 1971:36, 63, 70, 72). Unfortunately, it is not clear from Gonzales' writing where he had seen such hammerstones.

From one of the sectors in the Rumiqolqa quarries, Protzen reported 68 stone implements of different rocks. The hammerstones weighed between about 200 g and 8 kg. The largest ones were used for breaking up and squaring the blocks, the medium-sized for cutting the surfaces, and the smallest for drafting and finishing the edges. An experiment supported the argument. He believed that they were brought from the Vilcanota River, which runs near the site, or from an old river-bed to the north-west of the quarries. One of the tools found had a pointed end and would have been useful for sharp, concave edges (1983:4–6). At Kachiqhata, he found hammerstones as well. From there, he reports a total of sixteen hammerstones, most of them from outside the quarrying areas.

They were of varying compositions, although the majority of them were of quartzite, and he believes that the greater part of them are river cobbles (Protzen 1993:172–173).

According to von Hagen, stone celts were used by the inkas to shape stones. He also mentions stone hammers made from haematite, basalt and epidiorite and that stone chisels of these materials abound on many inka sites (1961:146–147). Outwater saw "very few tools" at Kachiqhata but mentions hammerstones, picks and wedges (Outwater 1959:28, 1978:583). Outwater's ability to distinguish such tools can be questioned, as he apparently took unused river cobbles lying in an old river-bed near Ollantaytambo for abandoned tools.

Valcárcel mentioned that, during archaeological work at Saqsaywaman, it could be proved that stones harder than those prepared were used to polish the walls (Valcárcel 1934*a*: 185). Unfortunately, he does not tell us anything about the context of the findings. Among the finds are bronze or copper artifacts, including cramps, chisels and small bars, but no interpretation of their uses is made. A copper bar from Saqsaywaman, near Cusco, is illustrated by Valcárcel (1934*b*:33, Figure 58). He thought that it might be an awl or a chisel. A metal bar found at Saqsaywaman in excavations in the 1980's was shown to me at the Instituto Nacional de Cultura in Cusco and might have been used in the preparation of blocks. It was about 35 cm long and 3 cm thick and very heavy for its size. One end was worn by blows. It was made of an alloy which contained copper, gold, arsenic, silver and lead and had traces of tin, charcoal and manganese.

In a study of use-wear marks on tin-bronze tools from Peru, Robert Gordon found that most of them showed damage that was probably derived from use on material harder than bronze, and he suggested stone (1985). Twelve of the thirteen artifacts were edge tools, and he suggested that they were used for chipping. Seven of these twelve would normally be classified as axe-heads, but Gordon believed that they were hand-held and that the stone worker would direct hammer blows on the cross-bar to chip the blocks. Another four of the twelve edge tools would be classified as chisels. Gordon thought that they were used to break chips or to split stone by inserting them and then by hammering them on top. Gonzales holds that the metal chisels of the inkas did not possess the hardness and consistency necessary for use in preparing stone. The only way they could have been employed would have been as wedges (1971:69).

In Gonzales' view, the final stage of preparing a block was accomplished by rubbing the surface with stones of a granular structure and as hard as or harder than the block prepared. The stones included some of the hammerstones that were also used for rubbing the edges. Sometimes water or some other element was employed between the tool and the block. The polished, glossy surfaces seen in some cases were achieved by

using river cobbles with an even surface or by using hide or wool, and by sometimes employing some intermediate element (Gonzales 1971:57, 65, 70, 73, 75). Other authors say that sand and water were employed for the fine preparation (González *et al.* 1981: 57). In an experiment, Protzen obtained a glossy surface by using a flat piece of andesite, together with a mixture of soil and water (1993:194).

There is a popular belief that the inkas knew how to soften the stone. One way suggested was by using the saliva of a certain bird. Another belief is that the inkas used herbs for that purpose (see Wiener 1880:475). The geologist Carlos Kalafatovich told me that he had made an experiment by placing a rock sample in a glass, together with a plant containing salicylic acid, and another rock sample in another glass with another plant which had a higher content of salicylic acid. The plants corroded the stones, but the process was so slow that he excluded the use of the method by the inkas. Oxalic acid, which is present in some plants, also corrodes stone (Carlos Kalafatovich, personal communication, Cusco, 1983).

In summary, a wide range of techniques has been proposed for the extraction, splitting and preparation of blocks. Some proposals are supported by field evidence, while others are merely to be regarded as hypotheses that remain to be tested.

Transportation

Installations for the transportation. From Kachiqhata, Outwater reported a sloping path built in overlapping zigzags for the transportation and noted a slide from it down to the ford with a block still lying in it (1959:30, 32, 1978:586). An inclined trail between the quarries of Kachiqhata and the chute towards the river was noted by Middendorf (1893–1895:3:522) and Squier (1877:508).

Both Astete and Harth-terré thought that the blocks from Kachiqhata were transported across the Vilcanota River by diverting the waters from one side of an island to the other, and Astete even thought that the island was built for that purpose (Astete 1952:224; Harth-terré 1965:162). Outwater, on the other hand, held that there was a built road across the river but under water and that the road continued to a ramp leading to the fortress of Ollantaytambo (1959:30, 1978:586). Harth-terré said that there was a ramp on the valley floor at Ollantaytambo (1965:162).

Agurto suggested that one way to move a block was to lift it and fill the cavity repeatedly. Then a short ramp would have been built on which to make the block move downhill for a short stretch. The procedure was thereafter repeated (1987:126).

Maps of installations at Rumiqolqa and Kachiqhata have been produced, including roads or ramps, and in the case of Kachiqhata also sev-

eral slides (Bengtsson 1991; Protzen 1983, 1985:162–166, 1986:83, 1993:138, 144, 148, 151–152).

Bedding for the transportation. Federico Kauffmann presents the possibility that the transportation downhill was facilitated by letting the blocks slide on trails with wet clay (1983:651; see also Agurto 1987:124). In Astete's view, the blocks transported from Kachiqhata would have been heaved upon slippery ground during the last stretch downhill towards the river (1952:223). That stretch corresponds to the slide noted by Outwater and mentioned above. Outwater is in favour of a "metalling" of the road surface by placing groups of three or four logs lengthwise, a section at a time. The blocks would have been moved on rollers on top of the bed (1959:30–32, 1978:586). Hollowell rather suggests the opposite, with sleepers on the ground and a sledge of runners on top of them (1987:139B).

A quite common piece of information is that rollers were used to move blocks (Rowe 1946:226; Harth-terré 1965:162; von Hagen 1961:149). Astete said that one was still visible at the Inkaqonqorina block at Ollantaytambo (1952:226). In the Spanish version of Outwater's article in English on the construction of the "fortress" (the Sun Temple) of Ollantaytambo, concrete information on wooden rollers has been added to the text, apparently by the editor, Rogger Ravines. Two rollers had been noted under a block close to the beginning of the temple ramp, and in the legend of an inserted photograph from the temple area, it is affirmed that rollers are still to be seen under a block there (Outwater 1978:Figure 3). Today, no rollers can be seen at the site.

It has been stressed that round stones were placed under the blocks to transport them (González *et al.* 1981:57). During archaeological work at Saqsaywaman, the use of stone balls to move blocks was proved, according to Valcárcel (1934*a*: 185). Unfortunately, he does not inform us about the context of their findings. Astete holds that the blocks from Kachiqhata were transported on stone poles, still lying about in the quarries, as well as on wooden rollers (1952:223, 226). Another opinion is that blocks were dragged directly on the ground (Protzen 1993:177).

Tools and other means of transportation. Agurto suggested that wooden frameworks serving as skates or sledges might have been placed under the blocks (1987:125), but Outwater excluded the use of sledges in writing about Ollantaytambo (1959:30, 1978:585). Another means proposed was a net placed over the block to be moved, and with ropes for pulling the block woven into the net (Protzen 1993:181).

Protuberances are found as distinct features on many of the blocks placed in fine-masonry walls (Figure 1*b*). They are considered by some to have been used in the transportation, either to protect the blocks' edges,

or to fasten ropes or both (Agurto 1987:125, 168; Velarde 1946:55; Harth-terré 1965:160).

The smaller blocks were supposedly carried in Utters (Outwater 1959:30, 1978:584; also see González *et al.* 1981:57). Agurto (1987:124) believed that even large blocks were usually carried in litters and that only the largest ones were dragged.

Wooden pry bars are mentioned by Rowe (1946:226), and the use of levers by Harth-terré (1965:162) and Agurto (1987:126). A long, tapered, tin-bronze bar from Machu Picchu analysed by Gordon (1985) was interpreted as a lever for moving stone blocks. It was not found in a stoneworking context but in a cave burial (Gordon 1985:312, see also Bingham 1981:208). Bars of tin bronze of different sizes in the archaeological museum in Cusco have been interpreted as levers as well (Gonzales 1971:77–78).They would have been used both to transport blocks and to place the blocks in the walls.

In local lore, the inkas are said to have known how to make the stones walk by themselves (own observation, Ollantaytambo; also see Valderrama & Escalante 1977:49; Gow & Condori 1982:29). With that view, there was no need for any tools or other means for the transportation.

Societal aspects

Time span

It was earlier thought by some that the fine masonry built with very large blocks dated from an epoch more ancient than the inka (for example, Bingham 1916:438, 444; Markham 1941:16–18, 33); others considered fine masonry built with polygonal blocks to be pre-inka (for example, Posnansky 1945:1:49). Others have tried to place all the different, fine-masonry styles in a chronological scheme (for example, Harth-terré 1965:Figure 1). It has been suggested that the polygonal masonry arose from a tradition of building with field stones and boulders, while the fine masonry with rectangular blocks arose from a tradition of using square-cut sods for house construction (Kubler 1984:460; Rowe 1944:25). The prevailing view is that the different styles were all used in late inka times, although Válcarcel believed that the empire lasted for about five hundred years (Agurto 1987:164; Rowe 1946:226; Valcárcel 1934*a*:185).

The burial houses in the Lake Titikaka basin pose a special problem. Some of them are certainly pre-inka, but others show such similarities to the fine masonry that they have been classified as inka on that basis (Hyslop 1977). However, burial houses built in such a technique have been radiocarbon-dated to the Late Intermediate Period as well as the Late Horizon (Pärssinen 1993). Apart from their potential as clues to the origin of the fine masonry technique, the labour process involved in

building them can probably be studied with good results (see Bandelier 1905).

Radiocarbon dates from the excavation of late prehistoric contexts in the Cusco region are still few in number. According to Bauer (1992:43–47), only three datings had been published at the time when he wrote that were from the excavation of clear Killke or Late Intermediate Period contexts. Only one was from charcoal associated with inka ceramics. To Bauer's list can be added two dates from the same floor level and associated with inka ceramics at Machu Picchu in the Cusco department (Berger *et al.* 1988:708–709). Another sample was associated with a floor in an inka building at Qata Casallacta in the vicinity of Cusco, but I do not have any information on artefacts from the same context (Ziółkowski *et al.* 1994:346). It can be worth mentioning the dating of human bones from graves/rock shelters at Machu Picchu, although apparently not all of them were the result of excavation in a proper sense. Bones from three of the five graves are probably from the Late Intermediate Period-Late Horizon, but the ranges are very wide in these instances (Berger *et al.* 1988:709). A human bone from a grave-house at Llaqtallaqtayoq in the Ollantaytambo district was dated to the Late Intermediate Period, but I have no information on any artefacts from the structure (Kendall 1995:46).

The fine masonry has usually been dated on the basis of the ancient, written information (for example, Alcina 1970:103). When excavating a site with fine masonry, the associated finds, especially ceramics, have been used, together with the written sources (Morris & Thompson 1985:56–58; Valcárcel 1934*a*:185). Of course, residues within buildings do not necessarily fix the time of construction. Inka ceramics, in turn, have been determined as to age and society by their association with fine masonry in the Cusco region (Rowe 1944:46–47). In that way, the age determination of the ceramics, too, leans on the written sources. The spread over a vast territory of the so-called Cuzco Polychrome pottery (Rowe 1944:47) seems to confirm its association with the inka empire, although no direct analogy should be made. Inka ceramics do appear in contexts that antedate the inka expansion, as it has been interpreted by Rowe (Pärssinen 1993).

The classification of the fine masonry in a single category and with the same origin and age has its basis also within another domain, although not so explicitly expressed, namely in the concept of shared features. The more variables that different objects have in common, the more probable is their common origin as to time and cultural sphere (see Maimer 1963). In the case of the walls, what binds them together is the pounded surfaces and striated edges of blocks and the very great accuracy in the fitting of one block to another. Moreover, there are traits that are

present in many walls but not in all, and their presence often overlaps in different walls, so that also these traits can be used to classify them together. Examples of such combinations are rectangular blocks with curved surfaces laid in horizontal rows; polygonal blocks with curved surfaces laid in irregular, horizontal rows; and rectangular blocks with flat surfaces laid in horizontal rows (see Figure 1). Also more complex, overlapping combinations can be defined, taking into account the rock quality, preparation marks, etc.

In the Cusco region, Killke ceramics have been reported from sites that are regarded as having been built on during the imperial inka phase. At some of these sites there are buildings of fine masonry (Gibaja 1982*a*:Ch. 6.05–6.06; Rowe 1944:60–62; Yábar & Ramos 1970:181–192). First defined by Rowe (1944), the Killke pottery is considered to belong to the Late Intermediate Period and to be a predecessor of the inka ceramics. Because of its connotation, it is sometimes referred to as Early inka. Gonzales reports on the Killke architectural remains that underlie fine masonry in Cusco (1984). Our knowledge is still fragmentary as regards the development and time span of the fine masonry.

Labour organization

As concerns labour organization, very little has been said on the basis of field evidence. Most authors rely on the historical sources (for example, Gasparini & Margolies 1980:306; Gonzales 1982). Protzen noted that the layout of quarries, such as those at Rumiqolqa and Kachiqhata, testified to a high degree of organization but went no further (1985:162). A few promising remarks on labour organization have been made about the site of Huánuco Pampa, but they do not refer to the fine masonry there (Morris & Thompson 1985:58, 69).

It is generally believed that those who participated in the stonework did so on a rotational basis *(mit'a)*, as a form of labour tribute payable to the state (for example, Rowe 1946:224). Some believe that the stoneworkers were specialized according to different tasks (for example, Gonzales 1982:21), while others rather emphasize that certain tasks were executed by way of trial and error (for example, Protzen 1985:179, 1993:195).

The methods of measurement are relevant to the labour organization of a construction project to the degree that they, in part, determine the extent to which it can be planned. The inkas' methods have been discussed to some extent in the literature, but the information in the historical sources is scarce, and not much field evidence has been added. A few objects classified as plumb-bobs have been recovered (Bingham 1915:184; Kendall 1989:Figure 76; Rowe 1946:225), and there have been attempts to understand the measures they used (Agurto 1987:255–281;

Ian Farrington, personal communication, Yucay, 1989; Rostworowski 1993c).

Miniature buildings of presumed inka origin have been recovered. They have been considered to be models for the planning of particular constructions (for example, Kendall 1989:122).[2] They might have been used to give a general idea of planned or existing constructions but are not detailed or accurate enough to have been transferred directly to construction. An alternative explanation for their use, and one which I find more likely, is that they served a similar purpose as the *enqas* of today. These small stone models are considered the repositories of well-being for the animals or households they represent, and they are used in ritual (Allen 1988:59, 163, 258).

Opinions vary as to where the different stages of the stonework w[7]ere performed. Velarde has it that the preparation of regularly shaped blocks took place in workshops outside the construction site, while the irregular ones were prepared once they were placed in a wall (1946:54). Von Hagen held that the stone was brought unfinished to the building site (1961:149), but, according to observations made at Rumiqolqa, the preparation of blocks was mainly done in the quarries (Protzen 1983:4). As regards Ollantaytambo, it has been said that both the rough and the fine preparations of the Kachiqhata blocks were carried out in the quarries (Astete 1952:223). Middendorf noted that a number of blocks had been left at a spot near the Kachiqhata quarries (1893–1895:3:523). This is the so-called storage yard mapped by Protzen (1993:144).

Harth-terré (1965:162, 164) said that those who worked in the quarries of Kachiqhata also lived there, and he presents a ground plan for their living quarters, consisting of six houses. In the view of another author, the workers at Kachiqhata lived in a village of at least forty houses built for them near the site, and they ate their own produce, which came from fields nearby (Outwater 1959:28, 1978:584). Others have maintained that those who were in the service of the state were supplied from the state storehouses (Morris & Thompson 1985:108; Murra 1975:38–39). A rare example of buildings that can be related to stonework is the description by Gonzales of shelters in the Waqqoto quarry. He presents the ground plans of two such shelters matched by photographs. The local population regards these shelters as being inka (Gonzales 1971:48, 54–55). House remains are also present in the Rumiqolqa quarries, and they are apparently thought to have been used by people involved in the inka stonework (Protzen 1983:3).

Labour security and health care

I am not acquainted with any research in the field of labour security and health care, as regards the fine-masonry construction. Using written evidence, this theme was treated with regard to the Roman quarries at Mons

Claudianus in Egypt (Cuvigny 1992). We lack written sources from inka society, but I believe that the topic can be fruitfully dealt with on the basis of physical evidence, as I hope to show by some observations and comments in the present study.

Motives

Exactly why the inkas built fine masonry is, to my knowledge, not known. Research related to this topic has concentrated on other issues, such as the use of specific buildings or the connection between a ruler and certain remains. We know from the ancient, historical sources that the fine masonry was related to religious, political, economic and astronomical activities. We also know that some of the buildings were used as palaces.

[1] A more detailed presentation of the different types of labour is given in section 3.2 on "Organization of labour in inka society".

[2] Such miniature buildings can be studied in the archaeological museum in Cusco. One miniature house-group is illustrated in Gasparini & Margolies (1980:Figure 171). Some other miniature constructions, including houses, are shown in Agurto (1987:252, 274–275, 281).

1.3 Ollantaytambo and the investigation area

The village of Ollantaytambo is situated in the deep Vilcanota Valley north-west of the city of Cusco in southern Peru. It is a modern village partially occupying prehistoric buildings recognized as inka. It is also the centre of a district with the same name, and a sector within the district has been given the status of an archaeological national park. It lies 68 km from Cusco, going by train, but can also be reached by road via P'isaq or Chinchero and Urubamba.

The prehistoric remains in the district are both numerous and varied. They include extensive terrace and canal systems, roads, houses, storehouses, sanctuaries, tombs and other features. Only some of the more well-known are briefly described here. Their connections with the stonework and with the so-called Sun Temple are far from clear. We can assume a strong connection in several instances, but the quality of the links has not been established. The presentation of Ollantaytambo should therefore be seen merely as an introduction to the general setting of the remains under study. Prehistoric remains in the Ollantaytambo district are treated or mentioned in a number of sources, and the reader interested in the details is referred to those sources.[1]

Geography and communications

Ollantaytambo has had—and still has—a crucial location, both geographically and economically, and in earlier times possibly also politically. The settlement is situated on one side of the valley floor at about 2,850 m a.s.l., with steep mountains on both sides (Figure 6). It is located at the crossroads between the *puna* or highlands, the *quebradas* or valleys, and the tropical lowlands. The Vilcanota Valley is very fertile and of major importance for agriculture, especially maize, and for transportation.

Prehistoric, constructed roads form a network, in which the settlement lies at a fork. The whole of the road network in the region has not been surveyed, but some stretches are well known and others are being explored. The roads extend along the valley floor and up gorges on both sides of the valley. They connect Ollantaytambo with such important inka sites as Cusichaca, Quente and Machu Picchu, on the one hand, and with Chinchero, Yucay, Calca, P'isaq and Cusco, on the other. In the mountains, they join yet other roads, thereby linking Ollantaytambo to other regions. On the south-western side of the valley, they reach one of the four main roads in the inka empire, the one leading through Chinchaysuyu or the north-western part of the empire. On the north-

eastern side of the valley, they extend into the ceja de selva (the subtropical-to-tropical, forest zone on the eastern slopes of the Andes) (own observations, 1974–1989).

Figure 6.
Aerial photograph of part of the Ollantaytambo district. The settlement is on the valley floor to the right in the picture. By courtesy of the Servicio Aerofotográfico Nacional, Peru.

On the valley floor, the Vilcanota River flows towards the tropical lowlands and the Ucayali River, a great tributary of the Amazon. A stream, the Patakancha, runs down through a narrow valley, passes through Ollantaytambo, crosses the valley floor and flows into the Vilcanota River. Its waters are used for a drainage system in the trapezoidal settlement, with a canal running along each narrow street in the village's longitudinal direction. Its waters are also used for the irrigation of the extensive and well-ordered fields in the gorge and on the valley floor by the village. The Vilcanota River and the Patakancha stream are canalized in the sections passing Ollantaytambo, the sides of the river and stream bed being lined with hewn stones in retaining walls. Both the drainage system, the irrigation system and the canalization of the stream and river are attributed to the inkas. These installations still form an integral part of the inhabitants' lives.

Terracing

As already mentioned, there is an extensive system of cultivated terraces near the village of Ollantaytambo. Between the village and the Vilcanota River, they have been laid out in a very rigid pattern and with high retaining walls (Figures 6 and 38). There are other sets of terraces that extend up the steep mountainsides to considerable heights. The most impressive set has been built on the Bandolista mountainside by the Patakancha Valley and covers about 1,000 m in height difference, as noted in an aerial photograph (Servicio Aereofotográfico Nacional, Lima, sheet 181-70-818).

Name

The first part of the name of the Ollantaytambo settlement is usually assumed to refer to a Captain Ollanta, who supposedly lived there during part of the reigns of the Inka rulers Pachakuti and his son Tupa Yupanki (for example, Angles 1978:2, 29–30). Ollantaytambo is referred to as Tambo and Tampu in chronicles of the 16th and 17 th centuries. A *tambo* was a place along a main route within the inka empire, where there were lodging facilities and storehouses with supplies of clothing, food and arms for officials of the inka government, for the army and for the population. Because of Ollantaytambo's location at a crossroads, we can assume that it actually functioned as a *tambo* or road station. There is some further evidence that Ollantaytambo did serve as a *tambo*, apart from the toponym itself and apart from its location at a crossroads. The actual *tambo* of Ollantaytambo seems to have been located in what is Manyaraki Square today. The term was still used for a place there in documents of 1629 (Glave & Remy 1983:3).[2] There is also a terrace carrying the name of Tambobamba, where it is assumed that crops for use in the *tambo* were cultivated (Glave & Remy 1983:3). Another field has the name of Qollqapampa (Collcabamba). As *qollqa* means "storehouse", that field was possibly used for growing crops for storage. Storage of foodstuffs was one of the important functions of the *tambos*. Maybe the name of Manyaraki Square has some significance in this respect, as Manyaraki appears to be composed of *mañay* and *raki*. *Mañay* means "to petition" in Quechua, and *raki* was an inka measurement consisting of a wooden basket, today used for the calculation of amounts of maize (Gade 1975:126). A further possibility is that there is a connection between the name of the village and a group of people called the Tambo. This will be further dealt with in section 3.3 on "Groups in Ollantaytambo possibly involved in the stonework".

The trapezoidal settlement

The ancient settlement has the shape of a trapezoid laid out in a grid pattern, with parallel cross-streets and with the longitudinal streets slightly converging towards one end (Figure 7). The settlement did not grow little by little but was clearly planned, since it has a finished, closed, four-sided, geometrical form. As already mentioned, it is regarded as having been built by the inkas. To my knowledge, only a few trenches have been excavated by archaeologists within its compounds, and the interpretation that it is inka is mainly based on its architecture. Each quarter is surrounded by a massive wall. These walls are partly built of fitted stones, although with less precision than, for example, the walls of the temple area. Within the walls are yards, or *kanchas*, with the dwellings of the present inhabitants. Some of the houses date from colonial times, while others are newly built. The majority are of prehistoric origin, and many of them have probably been continuously occupied since their construction (but see below).

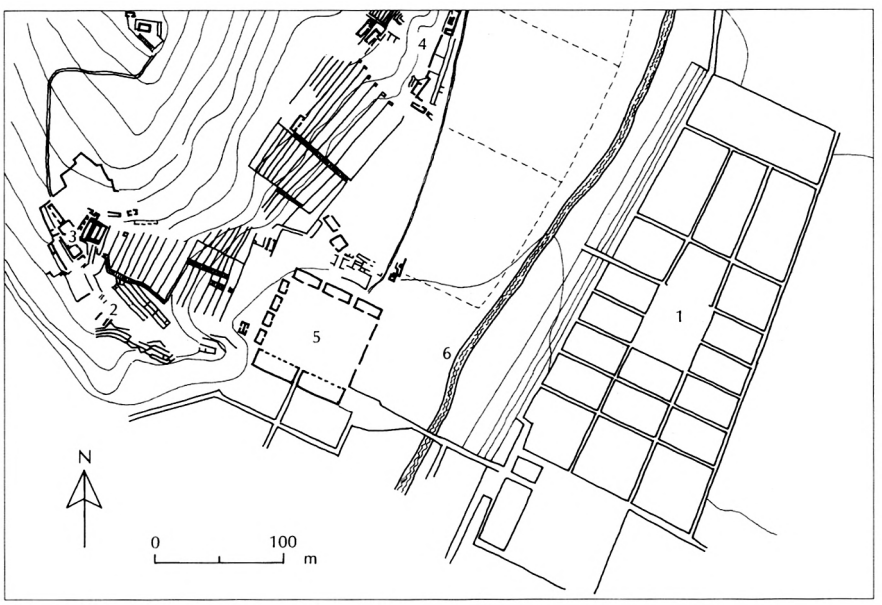


Figure 7.
Ollantaytambo. 1. Trapezoidal settlement. 2. Temple area. 3. Fortress. 4. Inkamisana sector. 5. Manyaraki Square. 6. Patakancha stream. Redrawn from Hyslop (1990:136).

Inhabitants

The trapezoidal settlement was probably inhabited by members of either the nobility or the army in inka times. The commoners would have resided in Quinchapata and in hamlets in the vicinity. Quinchapata was located on the cultivated terraces just south of the temple area, where the Capac Inca Ollanta cooperative is now (formerly Huatabamba/

Compone). People were moved into the trapezoidal settlement in the early 1570's, as part of Viceroy Toledo's programme to assemble the population into larger settlements (Glave & Remy 1983:2). The composition and history of the inhabitants will be discussed in section 3.3 on "Groups in Ollantaytambo possibly involved in the stonework".

Remains close to the Sun Temple

One important set of prehistoric remains is to the west and north-west of the village, on and by the Bandolista mountainside. This is where the so-called Sun Temple stands. Apart from the inner and outer temple areas, there are buildings referred to collectively as the Fortress, and there are terraces, carved rocks, tombs, canals, Manyaraki Square, and other buildings. The buildings include those constructed of fine masonry, such as those at Inkamisana, which were probably related to religion and rituals. Extensive excavation and restoration work were carried out in the sector at the beginning of the 1980's, under the auspices of the Instituto Nacional de Cultura and UNESCO (Gibaja 1982*a*), and the Instituto Nacional de Cultura later continued the work. Before that, minor archaeological work was undertaken in the 1930's (Valcárcel 1934*a*; Llanos 1936).

The quarries, the transportation route, and the building site

The different locations of the labour process under study here can be divided geographically into the quarries, the transportation route and the building site in the temple area. The rock-slides that were used as quarries and adjacent areas represent the richest segment of the three, with quite amazing vestiges. They therefore form the basis of many of the arguments and evaluations put forward here.

The quarries

The quarries lie on a slope called Kachiqhata, west by south-west of the village of Ollantaytambo, on the left bank of the Vilcanota River and between 400 and 800 m above the valley floor (Figure 8). They can be reached by crossing the bridge built on inka foundations over the river, close to the entrance to the village (Regal 1972:Figures opposite pp. 104 and 106) and then following a path up the slope, a walk of 5 to 7 km.

The quarries are located in two of the various talus cones formed by rock-slides coming down from an almost vertical rock-face, which is oriented towards the Vilcanota Valley. The rock-slides are extensive and contain such masses of boulders and stone that they are difficult to walk across (Figure 9).[3]

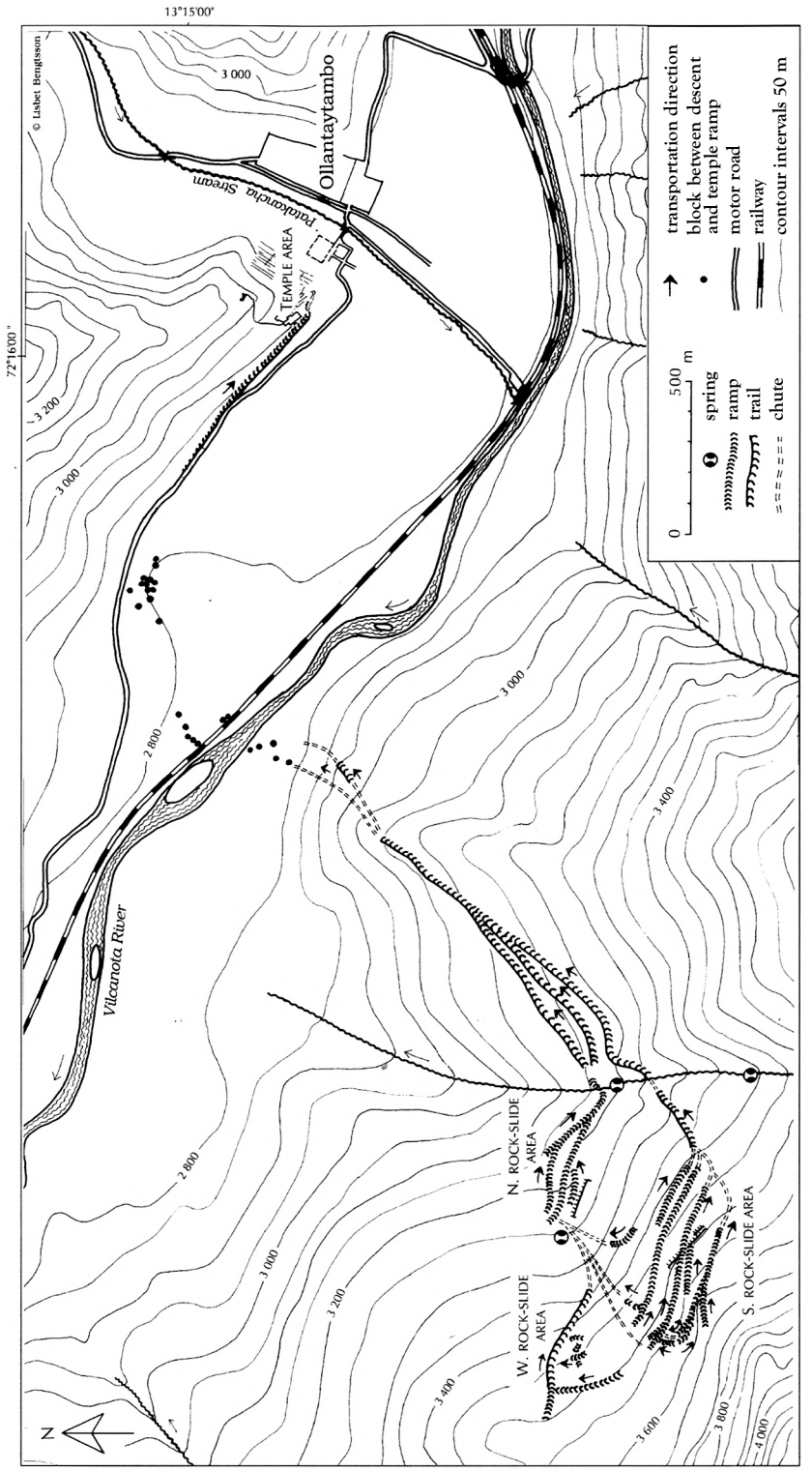


Figure 8.
Overview of the rock-slide areas at Kachiqhata, and of the transportation route to the building site in the temple area. The Ollantaytambo district.

Figure 9.
The southern rock-slide area.

The mountain, Allinyana (also called Yanakaka and Yanaorqo), is a huge, very cracked, granitic outcrop. It has a fissibility parallel to the bedding, now almost vertical, along which the rock breaks into layers (Figure 10). The locations of the quarries are well known, and they are mentioned or shortly described in several of the sources dealing with Ollantaytambo.

References to the quarries will be made by their relative locations: the southern rock-slide area, the northern rock-slide area and the western rock-slide area (Figure 36). The southern and northern rock-slide areas represent different rock-slides on the same talus cone. They in turn overlie more ancient rock-slides. The northern rock-slide must be older than the southern, since it reaches further down the slope and since an area consisting almost exclusively of stones on the surface (as opposed to boulders) separates the two. The southern rock-slide reaches only a short distance from its original source, the Allinyana mountain. The western rock-slide area lies on a less accentuated talus cone. The rock-slide areas have a somewhat wider geographical extent than the actual rock-slides, in that the term "rock-slide areas", as used here, includes the whole breadth of the cones of which they form part, and in the case of the western rock-slide area also a mountain shelf just below the cone. The parts of the rock-slide areas that lie outside the actual rock-slides include vestiges of stonework directly related to the rough preparation and handling of the blocks extracted from the rock-slides.

Figure 10.
The Allinyana mountain has an almost vertical rock-face.

The transportation route

The stretch of terrain that comprises the transportation route is measured from the edge of the rock-slide areas towards Ollantaytambo and to the edge of the temple area. As mentioned above, it covers several kilometres, and the height difference within it is quite remarkable. The building blocks were taken down the Kachiqhata slope, across a flat part of the valley floor, across the Vilcanota River, slightly uphill over the remaining part of the valley floor, and finally up the mountainside on the other side of the valley, to the spur where the temple was being built (Figures 8 and 11).

The building site

The building site within the temple area which is in focus here is located close to the settlement of Ollantaytambo. It is on a spur of the Bandolista mountain above the village (Figures 5 and 7). In what is defined here as the inner temple area, blocks of the reddish Allinyana granite were used for the front temple wall, in part for the two side-walls, and for another two, lower walls. The temple itself is a free-standing structure forming a platform. The temple's interior consists of both soil and bedrock, and the bedrock crops out above the surface.

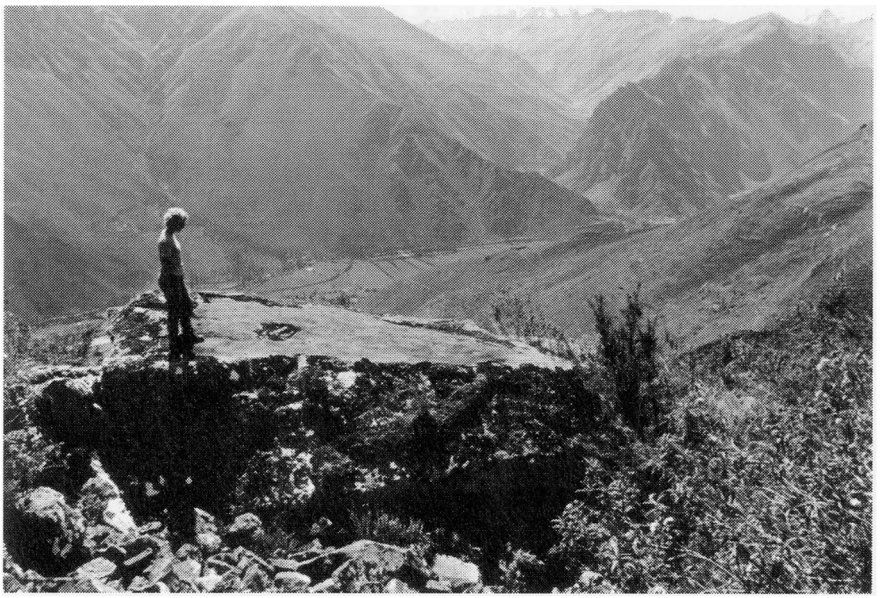


Figure 11.
The largest block recorded is in the southern rock-slide area. In the background is the valley floor and the ramp leading uphill to the construction site in the temple area. Block no. 102. Facing NE.

Single blocks of Allinyana granite lie strewn about the area; some lie on low, narrow platforms (Figure 5). Features of other material include the carved bedrock, a canal, a low wall built on top of the temple platform, and stones placed in mortar as a filling between the large blocks of the temple side-walls. They also include two walls of stones set in mortar built at the rear of both the front temple wall and one of the other two walls of fine masonry. A series of water basins just north of the temple is probably functionally related to the temple. It seems that the back of the temple is in part formed by the mountain itself and in part by a low wall of fine masonry built with blocks from some other source than Kachiqhata. The back of the temple has not been excavated (up to 1989). In front of the temple is a flat, open space, a space most probably originally flattened in connection with the building of the temple, if not before. The ramp used for the transportation of blocks from Kachiqhata ends here. Although the flat space has been cleared of débris and some excavation and restoration work has taken place, the majority of the single blocks lie in the same positions as they did before these actions took place.[4] They probably lie *in situ*, although the possibility cannot be excluded that they may have been moved when Manco Inka took action against the Spaniards in Ollantaytambo in the 1530's. The loose blocks lie in no visible, internal order and in a way that does not help us to determine any sequence in which the different blocks were to be included in the constructions. The presence of these single blocks, together with other indications, such as the layout of the walls as they stand, is important for our understanding of the site as a building complex that was never completed. Hollowell (1987:80) has argued that a major building

complex was commenced in the Manyaraki Square; it was dismantled before being completed, and the building blocks were moved to the mountain spur to build the fine-masonry terrace walls there and to erect the temple. His evidence is far from conclusive, and an in-depth investigation would be needed to study the issue.

What is referred to as the outer temple area in this study is located at lower topographical levels than the inner temple area. Three features are especially conspicuous. One is a set of terraces with fine masonry walls, built on both sides of the spur (Figures 5*a* and 38). Another is a hall with a beautiful wall with niches, also of fine masonry (Figure la). The hall was quite certainly an important structure, related to the function of the temple. A third feature is a great doorway, which presumably constituted an entrance to the inner temple area. There is also a flat space with some single blocks lying on the ground, and the carved bedrock popularly called "the Inka's seat" (Figure 61). The building material of the outer temple area is mostly of a dark, relatively fine-grained, acid rock (see Ahlgren in the Appendix).

[1] With no pretensions to completeness, the following list may be useful: Agurto (1987), Angles (1978, 1979), Baudin (1978), Bengtsson (1988, 1991, 1993), Bengtsson & Roslund (1990), Bingham (1910, 1916, 1977, 1981), Cieza (1986 [1553]), Cobo (1991 [1653]), Doering (1941, 1966), Garcilaso (c. 1980 [1609]), Gasparini & Margolies (1980), Gibaja (1982*a*, 1984), Glave & Remy (1983), Gonzales (1971), van de Guchte (1990), von Hagen (1961), Hardoy (1968, 1973), Harth-terré (1945, 1965), Hemming (1983), Huaycochea (1994), Kauffmann (1983), Kendall (1974*a*, 1974*b*, 1976*a*, 1976*b*, 1989, 1992),.Kubler (1984), Llanos (1936), Lunt (1987), Markham (1941), Martínez (1971), Middendorf (1893–1895:Vol. 3), Niles (1981), Outwater (1959, 1978), Pardo (1946), Pizarro (1986 [1571]), Protzen (1985, 1986, 1993), Rowe (1946), Sawyer (1981), Squier (1877), Valcárcel (1934*a*), Velarde (1946), Wiener (1880), Yábar (1971) and Zuidema (1963–1964).

[2] Originally from Biblioteca Nacional (Lima), Sala de Investigaciones, Manuscritos. B 1030. I will, as far as possible, provide information on the archival source, when I use second- or third-hand information on Ollantaytambo.

[3] When the term "boulder" is used in this study, it always means a natural boulder, which does not show any evidence of having been prepared. When the term "block" is used, I always refer to blocks of stone prepared by man. The term "large block" will be used for a block with at least two of its sides exceeding roughly one metre.

[4] Both the locations of single blocks and the state of the walls and layout of today were compared with the illustrations in Bingham (1916), Middendorf (1893–1895:3:515–516), Squier (1877: 496, 497, 500), and Wiener (1880:335, 337, 339, 476, 491, 501, 512), and with photographs by Martín Chambi (courtesy of Julia Chambi, Cusco, 1985). The photographs by Chambi are on glass plates and were probably taken in the 1920's and the early 1930's.

1.4 Methods and fieldwork

Methods

Most of the fieldwork consisted of surveys. I would walk over the terrain, sometimes accompanied by one or a few persons. Many of the observations, especially in the rock-slide areas, were made only after repeated visits. The equipment was simple: notebook, camera, tape measure, compass, clinometer, altimeter, measuring stick and aerial photographs from the Instituto Geográfico Militar at Lima.

The surveys were complemented by minor excavations. The equipment was the same as for the surveys, but with the addition of a levelling instrument and millimetre paper.

Fieldwork

The surveys were carried out in the three rock-slide areas, along the transportation route and in the temple area. Some surveys were made in adjacent areas. Built installations in the northern rock-slide area were mapped, but on account of source-critical problems—the blocks apparently coming from more than one rock-slide area—only one spot was used to further study the stonework in that sector.

We endeavoured to locate ramps in and by the quarries and took measurements of widths and inclinations; we studied the ways in which the ramps were built up, where this could be done by visual inspection; we scrutinized preparation marks on blocks, compared the locations of blocks in the rock-slide areas, as well as along the transportation route, and compared different sequences of the visible transportation scheme in different parts of the route. We took measurements of lichens in and near the rock-slide areas for dating purposes. Both sides of the valley were surveyed geologically, and rock samples were collected (Ahlgren in the Appendix).

We made test excavations at three spots in the quarries, at three spots along the transportation route and in the flat space in front of the temple (Figure 12).

Samples were taken for comparative purposes from one block, from flakes of stone from the preparation of blocks, and from pulverized stone from the preparation of blocks. Inorganic samples were taken for the determination of soils and samples of organic matter for age determination.

Altogether, I spent 16 months in the field, and most of that time was dedicated to Ollantaytambo. I visited other sites with fine masonry for comparison, many of which I had seen before, and also went to some of the quarries exploited in inka times. We spent some time surveying grave-houses, both in and near the rock-slide areas of Kachiqhata and,

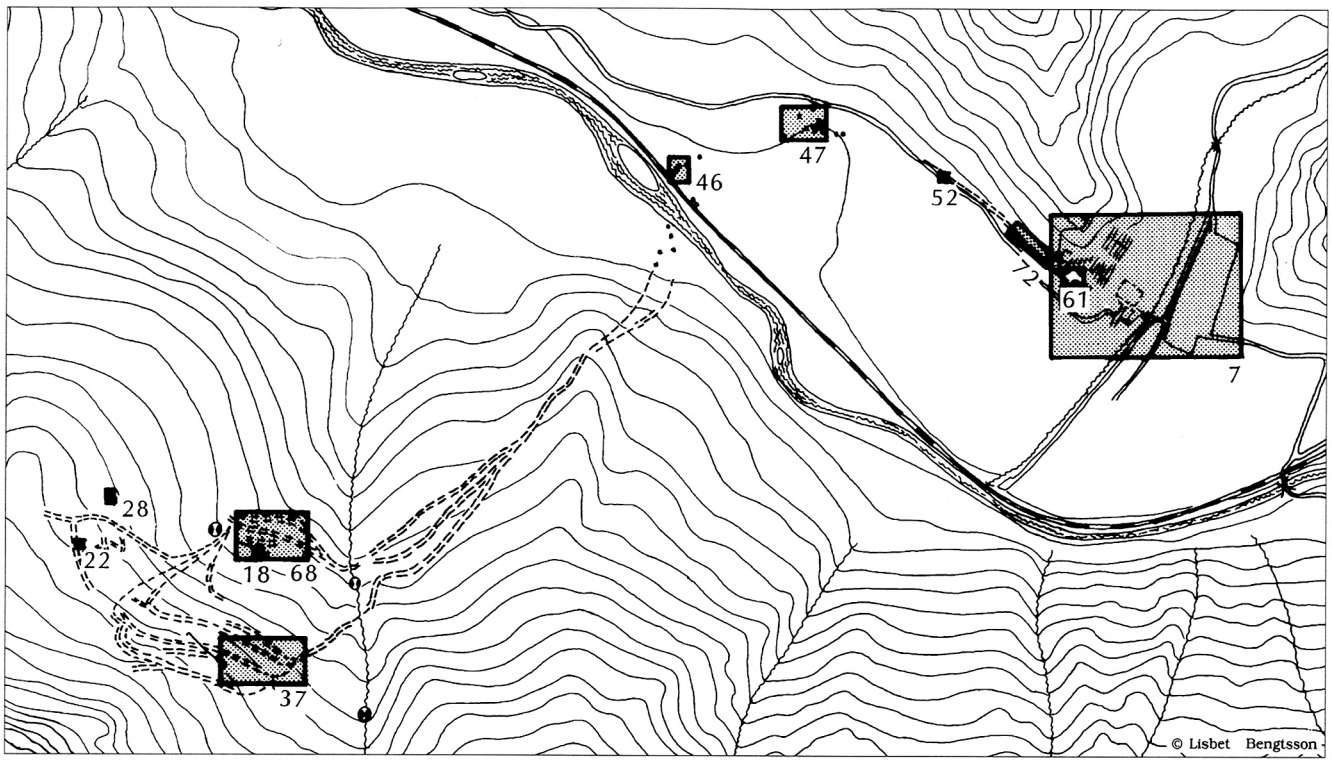


Figure 12.
The investigation area. The sections covered by more detailed maps are marked with their respective figure numbers.

for comparative purposes, in the Patakancha Valley (Bengtsson 1991, 1993).

In accordance with the rules, finds of ceramics, bone and stone were handed in to the Instituto Nacional de Cultura in Cusco, together with plans and basic reports (Bengtsson 1983, 1985*a*, 1985*b*, 1985*c*, 1986, 1989).

2 TECHNICAL ASPECTS

2.1 Raw material

The material used for the large blocks in the temple is from a reddish, coarse-grained rock, which is quite easy to distinguish from other rocks in the constructions at Ollantaytambo. The reddish rock is also the material of the blocks lying in the rock-slide areas of Kachiqhata and along the transportation route as defined here. In and near Ollantaytambo itself, most of the reddish blocks are in the temple area. A few are on and by the ramp leading up to the temple. Apart from these locations, there are a few single blocks in the fields below the spur and also close to the church by the Manyaraki Square. Moreover, a few blocks have been used for the entrance to, and the wall surrounding, the parsonage by the church.

Samples from boulders, from flakes of stone and from stone dust from the preparation of blocks in the rock-slide areas were analysed microscopically on the basis of thin sections, together with samples from one block, from flakes and from stone dust from the preparation of blocks in the temple area. They were all from the same rock, a sub-volcanic porphyrite, between rhyolitic and granitic, within the granite group. Although there were minor differences in colour, composition and grain size, they were all within the normal range (Stefan Klingberg, Department of Geology, Göteborg University/Chalmers University of Technology, April, 1986).

The relationship between the rock-slide areas of Kachiqhata and Ollantaytambo can also be studied on topographical and logical grounds. The precipitous face of Allinyana and the rock-slides on the Kachiqhata mountainside face north-east. As mentioned earlier, the village is at about 2,850 m a.s.l. The quarries lie at an altitude of about 3,200–3,600 m a.s.l., while the mountain top reaches about 4,500 m. The backland to the south and south-west of the mountain crest constitutes a *puna* (high grassland) stretching for miles in an undulating terrain, where settlements are scarce. To the east and south-east of the rock-slides, the mountainside continues to be steep all along the Vilcanota Valley, except where rivers have their outlets into the valley and break the terrain, forming deep gorges, narrow valleys and alluvial fans. To the west, there is such a gorge just a few kilometres away. Its side facing the Allinyana

mountain, where the Kachiqhata slope is located, is practically vertical and several hundred metres high (Figure 10). The only route possible for the construction material taken out of the rock-slides was towards the north-east, towards the valley floor.

Both the grain sizes and the sizes of boulders differ as between the rock-slide areas. This can be related to the structure of the Allinyana mountain. On account of the rapidity of the cooling process, different parts of the rock mass acquired different sizes of crystals. In general, the boulders of the western rock-slide area have smaller crystals than those of the southern. The boulders of the western area are generally thinner than those of the southern. This again can be related to the Allinyana mountain. The layers in the western part of the mountain face are thinner than those in its eastern part.

In a rock-fall talus, the finer material will stop in the highest part of the slide, while the heavier boulders will continue to roll further down the slope and assemble at the lower edge of the slide (Bates & Jackson 1987:573). When large boulders were wished for, we may assume that the extraction took place mainly in the lower parts of slides. This may explain why there are no ramps for the transportation of blocks in the upper part of the western rock-slide area. In the southern, there are single, very large boulders and blocks even in quite high parts of the rock-slide area. This does not alter the pattern, with the fine material closest to the mountain face and with no vestiges of stonework. Another section with fine material is between the southern and northern rock-slide areas. This supports the interpretation that the northern rock-slide occurred at a different time from that of the southern.

There are larger amounts of boulders in the western rock-slide area than in the other two. One possible explanation is that the workers started exploiting the areas that were closest to the building site. In line with this argument, the western was used only in the latest extraction phase (see also section 3.1 on "Time span"). Another possible explanation is that the rock-slide in the western area had not yet occurred, when the exploitation of raw material on the Kachiqhata mountainside started. Its exploitation would in this case have started shortly after its formation.

The mountain where the quarries are situated is being notably eroded. During a ten days' camp in the western part of the quarries, we heard rock-slides almost every day. We never had direct problems with them, only the worry. At night, I heard only one rock-slide, and the temperature was not below freezing-point. This means that the slides were not the direct results of frost cracking. One explanation is that almost frozen rock cracks at night and then, expanding in the heat of the day, finally comes loose.

There are probably several reasons why the rock of the Allinyana mountain was used for construction. The Allinyana bedrock presents

thick, geological layers and, on account of fissures, falls out of the mountain face. The size of the boulders, and consequently of the large blocks, is greater than the size of many of the boulders and other masses of rock used by the inkas for other constructions. Either unusually large boulders were actively sought for the construction at Ollantaytambo or that was merely a matter of secondary importance.

Granite is a durable and resistant rock, as compared with many others. Although fallen-out material weathers and is inferior to the bedrock itself, the fallen-out material from Allinyana is still of a high and uniform quality. The name of the mountain, Allinyana, is possibly ancient. *Allin* stands for good, and *yana* for black. The reason for the name that I was given was that the mountainis called black because it is black, even on its top and behind; and that it is called good, because, inside, it is a good mountain (Leoncio Monteagudo, personal communication, Ollantaytambo, 1985). The black aspect of the mountain is due to weathering, while the reddish colour can be seen in its newly exposed parts. One advantage, apart from the quality, was that the material presented itself readily in the form of boulders, and consequently there was no need to quarry it from the actual bedrock. This was, I believe, a key factor and outweighed the nuisance represented by the stretch of terrain that had to be covered in the transportation. The rock also has a special and uncommon colour, and this condition probably influenced the choice.

The only rock that could be mistaken by a layman for the reddish one used for the temple is a dark-red rock that was employed in the walls of the outer temple area. A dark red rock was also used for a large block that was left during transportation (Ahlgren in the Appendix). It lies in a field close to the railway station, off the route used for the blocks of Allinyana granite between Kachiqhata and the temple area.

A variety of rocks was utilized for the constructions in and near Ollantaytambo. Most of them are of a quality inferior to the reddish granite. Many boulders and blocks used for constructions were probably collected in the Vilcanota river-bed, as they correspond to the kinds of rock present in the Vilcanota River alluvium (see Ahlgren in the Appendix). An advantage of river-bed material is that it is free from cracks. Other blocks came from other sources, such as the Patakancha alluvium or the nearby mountainsides. One small outcrop south of the Vilcanota River near the valley floor was possibly used for the extraction of building material, but the evidence is not conclusive. The source of the green rock used, for example, for the low, back wall of the temple is not known. The origin of the dark-red rock utilized for the fine terrace walls of the outer temple area is not established, although Protzen reports a possible quarry on the Pinkuylluna mountainside (1993:158; cf. Ahlgren in the Appendix).

2.2 Splitting

Figure 1 3.
Splitting groove in a large block in the western rock-slide area.

There are strikingly few vestiges in the investigation area of blocks being split. In all three rock-slide areas, I recorded a total of six cases of blocks with evidence of splitting. They were noted in both the southern and the western rock-slide areas. They had a splitting groove along one of the long sides of the block. Such grooves are the only indicative signs of cleavage that I encountered. The grooves vary in width between 2 and 12 cm and are quite shallow (between about 1 and 5 cm in depth) (Figures 13 and 14). The grooves were made by hammering. The hammering was done with a tool with a round edge. They were most probably hammerstones, as can be argued from the vestiges discussed in section 2.3 on "Rough preparation".

Figure 14.
Splitting groove in a large block in the southern rock-slide area.

It is significant that, in most of the cases, a fissure can be observed in the deepest part of the groove. Usually, the fissure is visible all along the block's surface. It seems clear, therefore, that the masons possessed some knowledge of cleavage planes and that they knew that the easiest way to split a boulder was to utilize a natural fissure.

The Allinyana material has three cleavage planes. The primary or natural cleavage plane forms layers, which originally were more or less horizontal to the earth's surface. Through movements in the earth's crust, they now stand almost vertically in the Allinyana rock-face and are clearly visible as fissures (Figure 10). The fissures follow the "bottom" of the mineral particles. This is the cleavage plane along which it is easiest

to split a bedrock or a boulder. The secondary cleavage plane would in the rock's original position have been vertical. In the rock-face as it appears today, they form the front. They are more or less at right angles to the primary cleavage plane, and they follow the "long sides" of the mineral particles. The secondary planes are in general parallel to each other but somewhat at an oblique angle to the primary cleavage planes. In the case of the Allinyana rock-slides, the boulders are naturally split along the primary and secondary cleavage planes, forming more or less rectangular prisms. The third plane is the most difficult for a stoneworker to deal with. To split a boulder along this line means that the split will cut through the short ends of the mineral particles. Among Swedish stoneworkers, this plane is known by the illustrative term *borst*, meaning "bristle". Among the boulders in the rock-slides at Kachiqhata, these sides are the most irregular. They form the short ends of the boulders. The few attempts at cleavage that I have seen in the rock-slide areas have been made along the primary or secondary cleavage planes. I recorded none along the third and most difficult plane.

In one of the blocks with splitting grooves in the rock-slide areas of Kachiqhata, the block has actually split into two (Figure 15). I scrutinized the edges on both parts but did not see any sign of a blow or blows or any other alteration that would tell us exactly in what manner the final split was made. As a tentative suggestion, this block was left with its splitting groove made but before it was actually split. Later, the block split naturally by means of weathering.

Figure 15.
Block split into two parts. The western rock-slide area.

Within the rock-slide areas, not one single case of wedge holes or slots was recorded, and not one single case of bar holes. This was in spite of the fact that hundreds of blocks in different stages of preparation were scrutinized, and in spite of the numerous statements about the presence of wedge or bar holes in inka quarries and about the use by the inkas of devices such as chisels and wedges (for example, Arnold 1983:89–90; Gonzales 1971:31–32; González *et al.* 1981:56–57; Gordon 1985:323; von Hagen 1961:147; Lorena in Martínez 1971:54; Outwater 1959:27–28, 1978:583). We found one single flake of stone, which had been struck with a tool with a straight edge. This find from the western rock-slide area will be discussed in section 2.3 on "Rough preparation".

The Spaniards introduced mills into the Andean region, and two unfinished millstones low in the western rock-slide area belong to the post-inka period. They are at the same time the only vestiges hitherto found that indicate any use of the Kachiqhata rock-slide areas in the post-inka period.

I looked for signs of the use of heat on the blocks with splitting grooves and along the edges of other blocks. Several authors suggest the use of heat as an aid in splitting blocks (for example, Astete 1952:223; Frank 1980; González *et al.* 1981:56; Lorena in Martínez 1971:53). If heat

was actually used, I expected to find visible damage to the stone, such as minute, superficial cracks, exfoliation, extra weathering and a change in colour. No such vestiges of the use of heat were encountered, and my conclusion is therefore that heat was not used as an aid in splitting blocks in the Kachiqhata rock-slide areas.

Between Kachiqhata and the temple area, only three cases with wedge-shaped holes were recorded. One of the blocks has been used as evidence that the inkas employed wedges for splitting blocks. It is a large block lying close to the motor road (Protzen 1993:Figure 8.2). It is finely prepared, with a finished shape and a relief on two of its sides. The wedge-holes do not follow a single direction and they have nothing in common with the vestiges of splitting that do exist in the rock-slide areas. The fact that the block is finely prepared, with a finished shape and a relief on two of its sides, instead supports the interpretation that it is a block that has been exposed to later damage. Its accessible location close to the motor road and close to Ollantaytambo itself further supports this argument. The reason for the wedge-holes may have been that, at some point in its history, an attempt was made to take advantage of this high-quality block, too immense and heavy to handle in its present size with the means available. The other blocks are in the Vilcanota river-bed. When the water is low in July, the blocks are on dry ground. They were recorded as dark red in colour and lie off the transportation route for the blocks from Kachiqhata. At least at this point, I find it hard to believe that their wedge-holes date from inka times. Hollowell reports several of these blocks in the same sector, although he calls the holes chisel holes, and says that these blocks had formerly been part of the wall channeling the river and were apparently being broken up to be re-used. In his words, the blocks are of basalt (1987:11). Very similar holes are to be seen in the settlement of Ollantaytambo, where the Spaniards wanted to widen the entrances to the courtyards, so that horses with loads could pass.

In the temple area, there is one block that is partly split (Protzen 1993:Figure 10.7). Although not of Allinyana material, it deserves some attention, since it has been used as a proof that the inkas sawed blocks to split them. Most of one side of the block is missing, and the remaining face is vertical. In its lower part, where the block is not split, a score can be noted. The score itself is a natural fissure, which has become filled with calcite through a process of leaching from the adjoining rock. Calcite still remains on the vertical face of the block. The same phenomenon of calcite-filled fissures can be observed in the bedrock in the nearby Inkamisana sector. No saw was necessary to split the block, which may have fallen apart for natural reasons along the fissure with the comparably soft calcite or with minor help by man. On the other hand, there are signs of a tool having been used in the bottom of the score. Very simi-

lar marks have been formed in carving a rhombic pattern with parallel grooves into a "seat" in the bedrock at Inkamisana (Protzen 1993:Figure 10.8). A piece of rock with apparently the same marks and design was found during excavations in the 1930's (Llanos 1936:Figure 8, reg. no. 5–787). We do not know what tool was used for the purpose, but, judging from the marks, it had an edge about 2.5 mm broad. No similar marks were found anywhere in the rock-slide areas or in blocks along the transportation route.

We have not located any other blocks in the temple area with signs of being split, and we found no blocks with wedge or bar holes. There are no blocks with a splitting groove, like those in the rock-slide areas. Quite clearly, in the few instances that it was considered necessary or convenient to split blocks, the procedure was performed already in the rock-slide areas.

Maybe more important than the few vestiges in the rock-slide areas of the act of splitting is the fact that markedly few vestiges are present. I would say that splitting was actually avoided. One reason for this may have been that the masons found the task difficult. The tools and other means that they had at their disposal were simply not very apt for such a purpose. Another reason may have been, as argued in section 2.1 on "Raw material", that the constructors of the buildings near Ollantaytambo preferred the large blocks that could be extracted from the Kachiqhata rock-slides. In using large blocks, splitting was not necessary.

2.3 Rough preparation

The work of giving a block its rough shape was performed in the rock-slide areas but not along the transportation route or in the temple area. There seems to be one exception to this rule. This is found at a spot outside the rock-slide areas but still on the Kachiqhata slope at a locality called Nawinpata. There is an agglomeration of blocks at this point, which has been called a storage yard (Protzen 1985:164, 1993:147). Protzen noted waste on the surface at the site and, if we compare it with the evidence from test-point 6, it was probably a workshop, in addition to being a storage space (see below).

Installations

There are some installations in the rock-slide areas which facilitated the preparation of blocks and which were most probably made primarily for that purpose. They include a workshop terrace, platforms, flattened spaces, scaffolds and piles of stone.

The *workshop terrace* is located in the northern rock-slide area, in a steep part of the Kachiqhata slope, and it is unique of its kind (Figures 16 and 68). I assumed that the terrace had been especially constructed to obtain a flat space where blocks could be prepared. This is in opposition to Protzen, who calls it a retaining wall protecting the stone-extraction areas from rockfalls and possibly stopping large boulders from sliding down the slopes (1993:140). It was hardly made for cultivation, as its soil

Figure 16.
Workshop terrace in a steep part of the Kachiqhata slope. The northern rock-slide area. A grave-house (no. 33) stands slightly above the terrace, to the far left in the picture.

has a very low humus content. No canal supplies water to the stony surface; on the contrary, a canal passes along at the base of the terrace wall. One large block lies on it, and parts of its sides are finished as far as rough preparation is concerned (Figure 17). Other parts of the block were either only slightly prepared or not prepared at all. One of the test-points chosen for excavation, test-point 7, was beside this large block. If my argument was valid as to the purpose and function of the terrace, there should be flakes and also stone dust in the ground by the block. A trench was excavated along two sides of the block (Figure 18). There were flakes and stone dust of the same rock as the block itself in a layer 10–26 cm thick on the eastern side of the block, thinner on the northern side (Figure 19). Some flakes were also found in a small test-pit opened 6 m away from the block. Whether the only reason for building the terrace was to prepare blocks on it, we cannot know with certainty at this stage, but it is quite clear that it was indeed used for such a purpose. The block on the terrace was abandoned during its preparation and was, as far as can be determined, left on the very spot where it was being prepared.

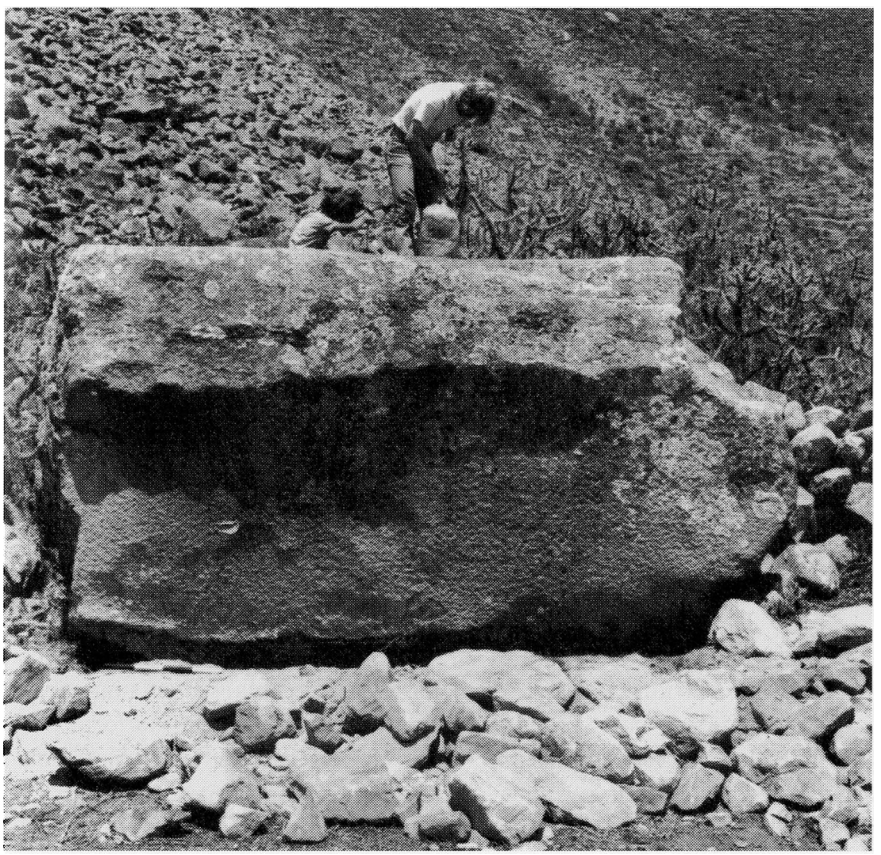


Figure 1 7.
Block on the workshop terrace. The lower part of the block side has been roughly prepared, while the part along the upper edge has not been prepared at all. Test-point 7, the northern rock-slide area. Facing W.

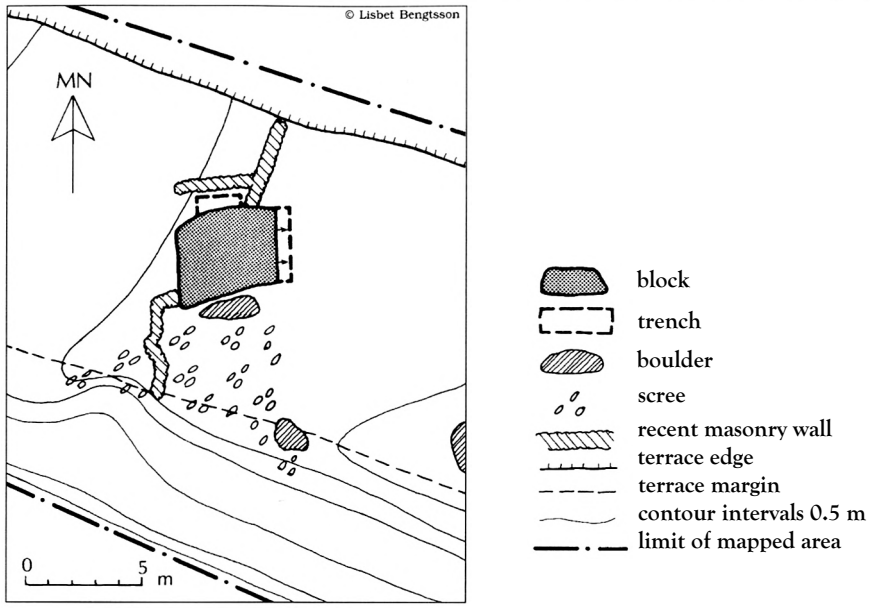


Figure 18.
Two trenches were opened by the large block on the workshop terrace. Test-point 7, the northern rock-slide area.

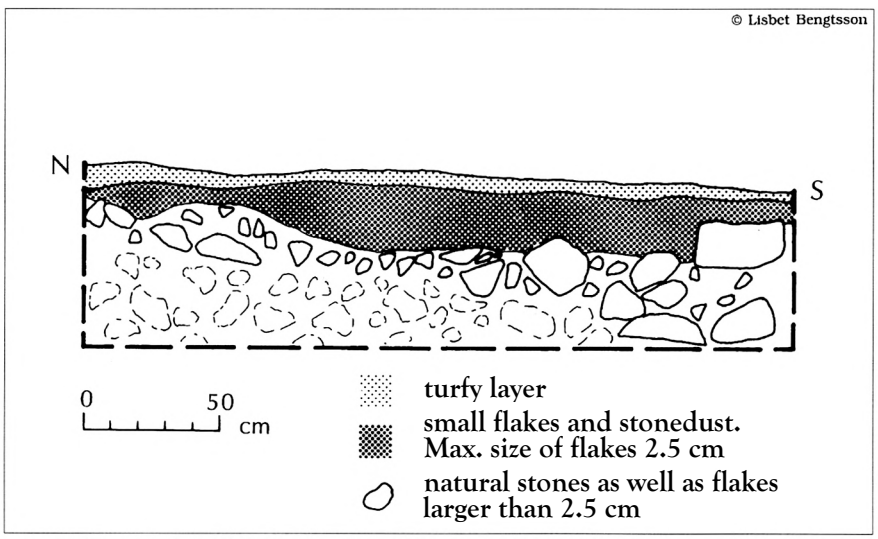


Figure 19.
Flakes and stone dust formed a layer in the ground by the large block on the workshop terrace. Test-point 7, the northern rock-slide area.

Platforms are typical of the southern rock-slide area, where single, large blocks lie on them (Figure 20). In one case, an empty platform was noted, and the block had probably already been moved. These platforms are built with a wall along their low sides and with a stone filling and provided a flat working space for the preparation and handling of blocks.

Figure 20.
A platform with a large block on it. Block no. 102, the southern rock-slide area.

A few *flattened spaces* were noted within the actual rock-slide of the western rock-slide area. The ground had been deliberately filled with stones of more or less the same size, taken from the rock-slide, quite certainly to provide a suitable working space. They are less distinct in their construction than the platforms. Various prepared blocks lie on each one of them, and our excavation in one such flattened space showed that it was a workshop where preparation took place. At the spot chosen for excavation, our test-point 6, various blocks had been placed in order, side by side (Figure 21). This procedure must have facilitated the subsequent preparation of the blocks. The blocks there are quite long and thin and are popularly called "needles". Possibly they were destined for lintels.

Figure 21.
Flattened spaces were used as workshops. In the photograph, prepared blocks lie side by side. Test-point 6, the western rock-slide area. Facing ENE.

A trench was excavated between two of these blocks (Figure 22). Comparatively large flakes, larger than 5 cm, were found in a layer formed by stones about 15 cm in diameter (Figure 23). The stones formed part of the artificially flattened ground. The flakes did not occur in large amounts. Deeper down, the ground consisted of larger stones and boulders, which formed part of the rock-slide. In between them, there were smaller flakes, in considerable amounts. They had quite clearly fallen through air pockets from the layer above and down to a deeper level. They amounted to several hundreds. It can be assumed that more material had been deposited even deeper down, but the boulders impeded a further excavation. Rough preparation of blocks clearly took place at the spot, but I would not consider the preparation carried out at this spot as very extensive before the stonework ceased. The classification as a workshop must still be considered valid.

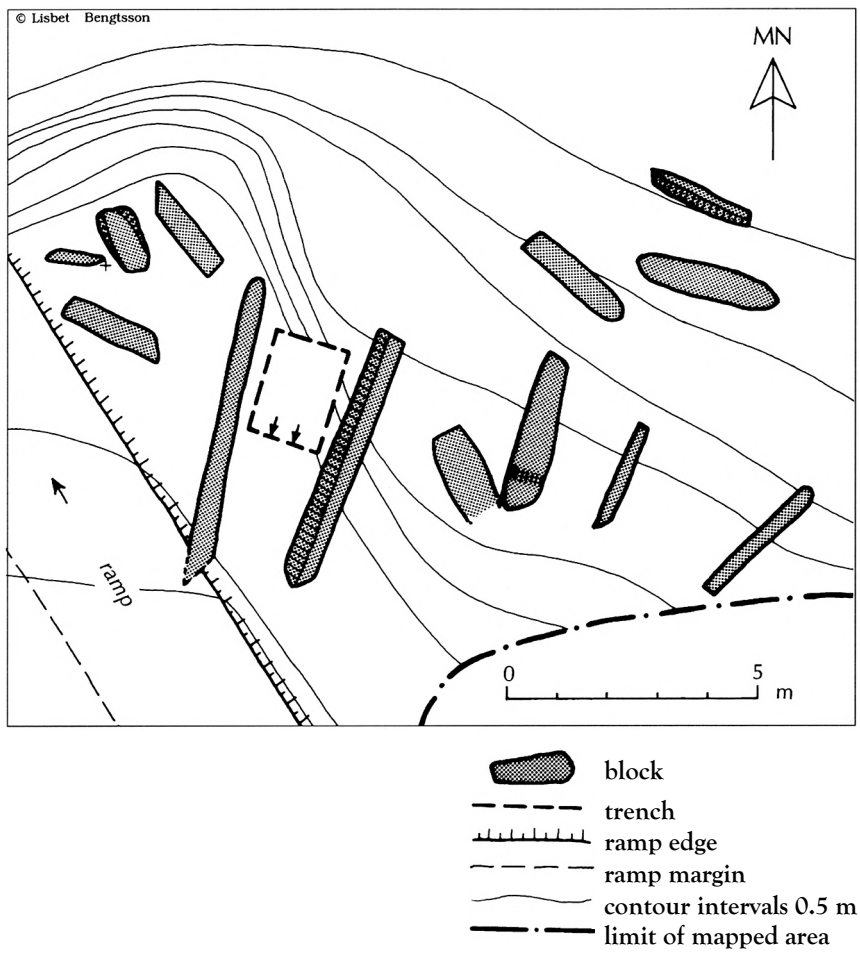


Figure 22.
A trench was opened between two of the blocks at test-point 6. The western rock-slide area.

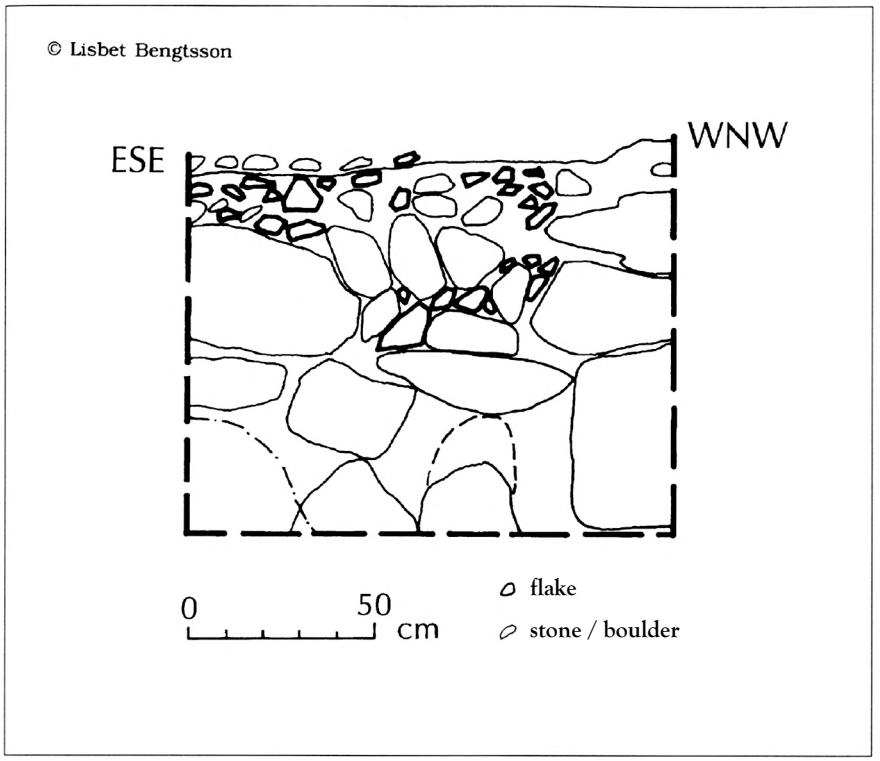


Figure 23.
In the ground, flakes lay mixed with stones and boulders. Test-point 6, the western rock-slide area.

The features which I call *scaffolds* are simple, low, stone walls usually built right onto a block (Figure 24). I have noted them in the southern rock-slide area. In some cases, they are rather constructed like narrow platforms. I have called them "scaffolds", because it seems that one use for them was to provide a ledge on which to stand when preparing the upper parts of the high side of a block or when preparing the upper edge. They could also be used when a stoneworker wanted to climb a block to prepare the upper surface by sitting on top of the block. In some cases, the block is so low that a scaffold would not have been necessary. In those instances, I do not have an explanation for their use.

Piles of stone either support the edge of the short end of a block or the edge of a long side (Figure 25). I have recorded such supports in both the southern and the western rock-slide areas. They facilitated the preparation of the lower part of a block-side which would otherwise have lain on the ground, sometimes in an oblique position. They would furthermore have facilitated the preparation of the bottom surface of the block in its present position and also made the banking of a block easier.

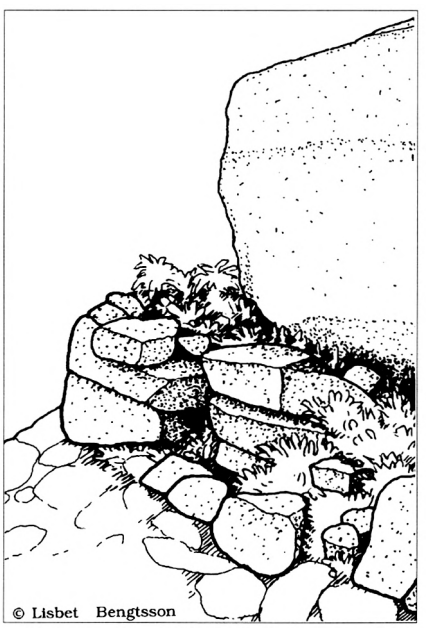


Figure 24.
A scaffold built onto a large block. Block no. 103, the southern rock-slide area.

Preparation

In general, flakes were struck from the edges of a block, while the sides were pounded more or less at right angles to them. This means that the

unwanted material of the sides was reduced by crushing rather than by flaking. The usual procedure was to start the preparation by striking off flakes along one edge of the boulder. The sides were made straight but without otherwise altering the size of the block. Blocks in all three rock-slide areas show clear marks both of the flaking off of edges and of the pounding of surfaces (Figures 25 and 26). This holds true also for blocks along the transportation route. For blocks in the temple area, the vestiges of the procedure during the rough preparation have in most cases been obliterated by the later fine preparation.

Figure 25.
Block with marks from the flaking on the lower edge. Stones are piled up along its side. The western rock-slide area.

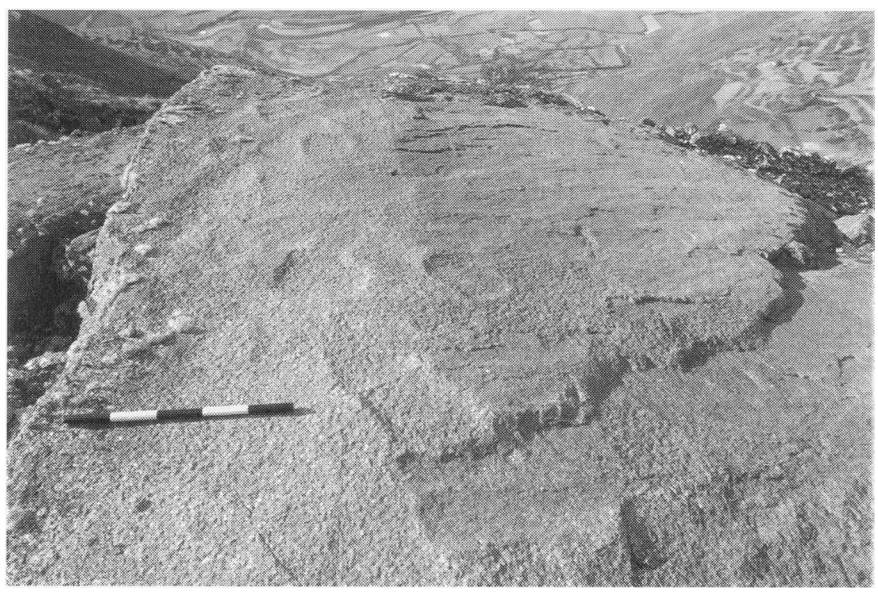


Figure 26.
Block with preparation marks from the pounding of a surface. The surface is quite even. Block no. 101, the southern rock-slide area. Facing NNE.

All the vestiges of preparation have been left by mechanical ways of treating the blocks. There are no signs whatsoever of the use of acids, a means used by the inkas according to popular belief.

There is a difference between the blocks in the western and southern rock-slide areas in that many of the blocks in the western area are thin and the striking of flakes from the edges therefore removed much of the unwanted material of the block. On the contrary, large blocks are more common in the southern rock-slide area, and the bulk of the rock mass still had to be removed after the flaking of the edges. That was done by pounding the surfaces.

Flakes can be found lying on the surface in the rock-slide areas. They are not always easily distinguishable in the actual rock-slides, since they have the same colour and grain size as the natural débris on the ground. Another factor is that flakes are often of a smaller size than the natural debris and have a tendency to disappear in between the larger-sized material. Most flakes left on the ground outside the actual rock-slides would have become covered with vegetation. The finer material that would have been the result of pounding is even more difficult to distinguish on the ground. The excavations at three points in the rock-slide areas helped to elucidate the labour process in this respect. Two of them, test-points 6 and 7, have been briefly described above. The results of both were that it was confirmed that there are flakes in the ground, and that at test-point 7 there is also stone dust from the pounding.

Another place chosen for excavation, test-point 5, was below the actual rock-slide in the western area. I considered this to be a storage space for blocks that were awaiting subsequent transportation to the valley floor. Although difficult to see from a distance, it is a notable spot, in that a couple of hundred blocks lie together in between cultivated fields (Figures 27 and 28). The blocks are comparatively small, most of them measuring less than 1 m in length, and many lie in neat rows (Figure 29).

The results of that excavation confirm the use of the site as a storage space. The blocks could not have been prepared in their present positions, as there is not enough space around them, in the way they lie now.

Another and more surprising result was that the site was also a workshop. Rough preparation of blocks had taken place at the very spot. Flakes with a diameter of 1–33 cm were in a layer a few centimetres thick at and just below the bottom surfaces of the blocks (Figure 30). In the 16 m^2 excavated, there were 1,950 flakes, and this was only in the narrow spaces in between blocks, since we left the blocks where we found them. The blocks had been moved about after the flaking took place, so that, in the sector we excavated, some blocks could be seen lying right on top of flakes. I suggest that blocks were moved about within the site, so that, after being roughly prepared, they were placed close together, in rows as

well as being piled on top of each other, so as to make more room for the other blocks to be prepared at the site.

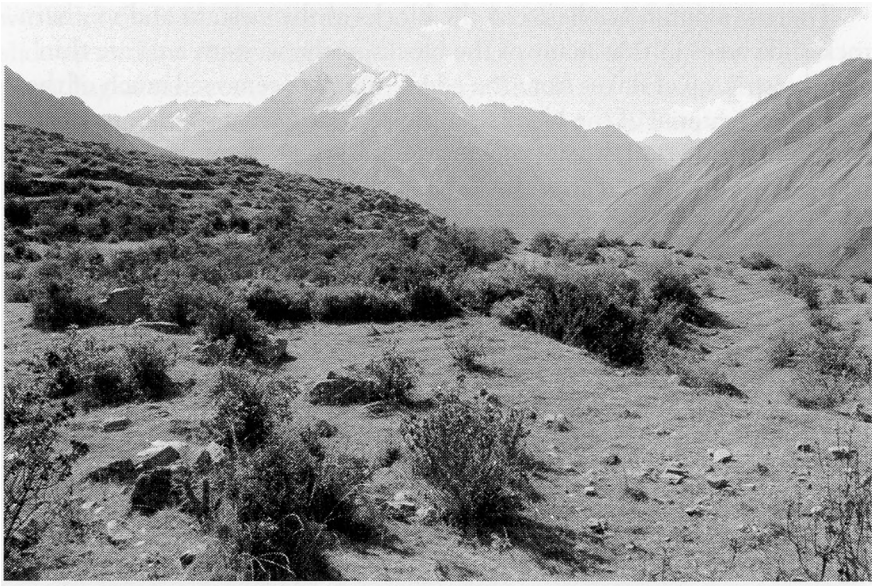


Figure 27.
Test-point 5 was in a space with spiny shrubs in between cultivated fields, where a couple of hundred blocks lie. The site is in the centre left in the photograph. The western rock-slide area. Roughly facing N. Its location can be seen in Figure 21.

Looking at the surfaces of large blocks, the preparation marks made by pounding take on different appearances. Some patterns are rounded, others rectangular; some form vertical furrows on a block-side, and others form quite an even surface (Figures 31, 32, 33, and 26). Different patterns may be seen on one and the same block. The reason for the different patterns has, as far as can be judged from the crush marks, nothing at all to do with the tools used. My suggestion is that we see here the results of preferences among different stoneworkers or groups of stoneworkers.

It can often be discerned in which position a block lay during its preparation. What is now a block-side was often prepared in its present vertical position. The blow was directed towards the block-side but with a tendency to a downward motion. Apart from the crush marks, the marks from the chips removed by the pounding can be distinguished. They form at the lower ends of the crush marks. That is also a reason why the patterns in general are less distinct at their lower ends. This is due to the weight of the tool and to the anatomy of the human body. The arm can be used only within a certain range to give an effective blow. To work at this task for a long time must have required that as comfortable a movement as possible should be used or allowed for. If we look at the patterns formed, it is therefore natural that the furrows and rectangular patterns shown in blocks 102 and 101 in Figures 32 and 33 should occur on the sides of blocks, because it is unlikely that a sideways

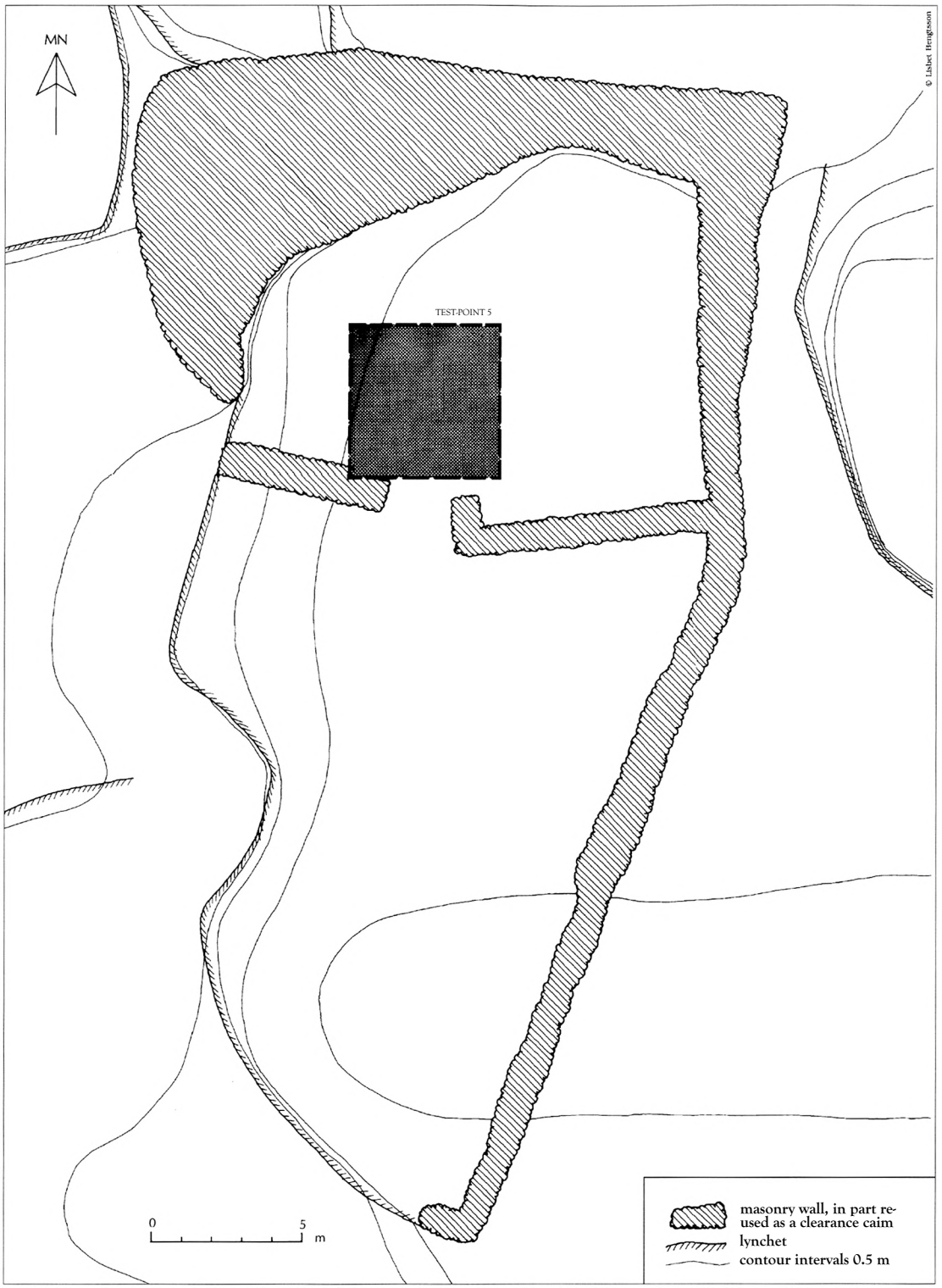


Figure 28.
The space between the lynchet leading in a roughly north-south direction and the wall to the right leading in the same direction contains the couple of hundred blocks mentioned in Figure 27. Test-point 5 was placed within that space (see Figure 29). The western rock-slide area.

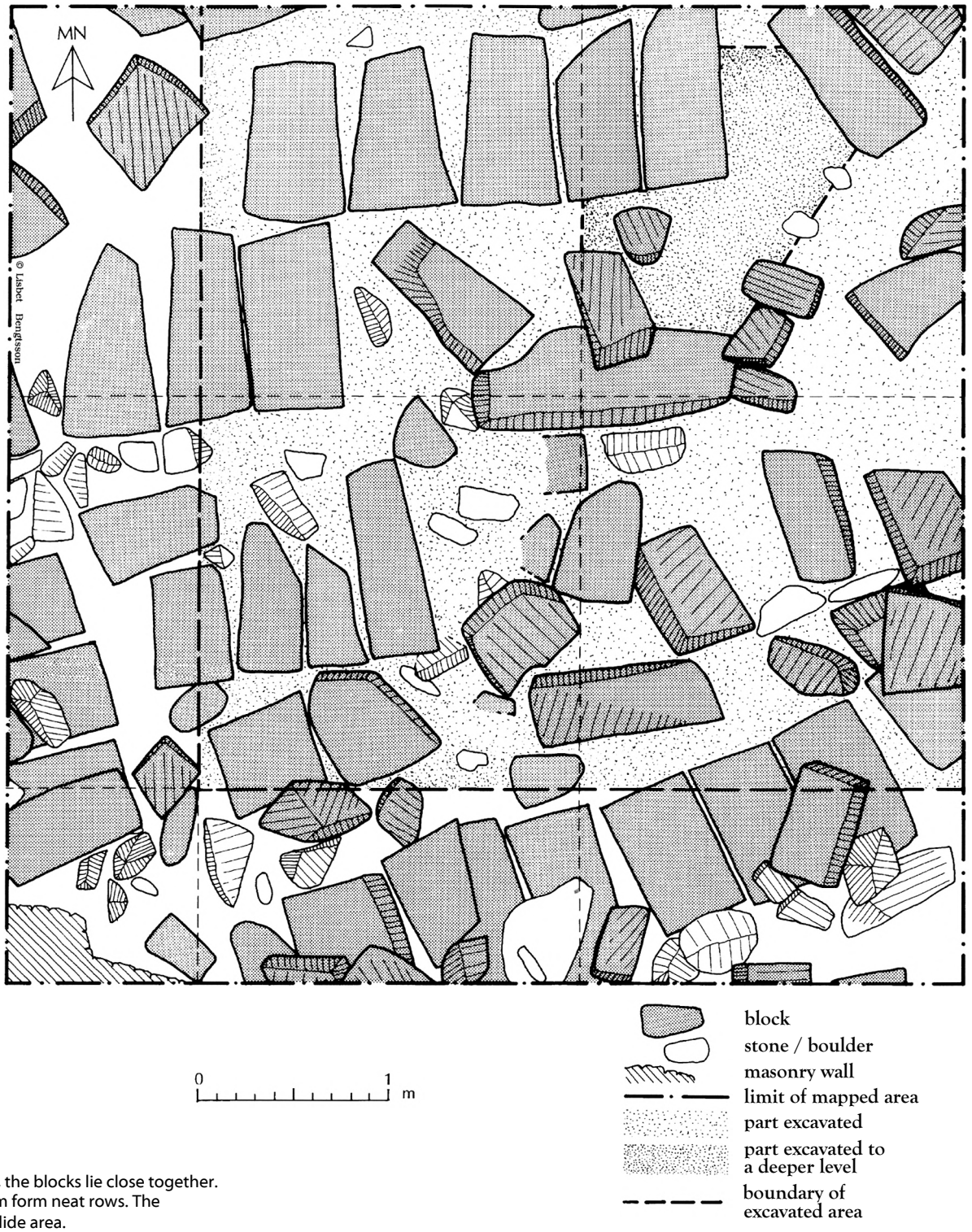


Figure 29.
At test-point 5, the blocks lie close together. Several of them form neat rows. The western rock-slide area.

Figure 30.
Excavation at test-point 5. Flakes from the excavation have been placed on top of the blocks. Facing ENE.

movement would be used. We can thereby argue that those blocks lie in the same position as when they were being prepared.

Tools

In general, the flakes in our excavations were formed by striking the block with a tool with a rounded edge. This is stated on the basis of the shape of the platforms on the flakes. The pounding of surfaces was also done with a tool with a rounded edge. This can be judged on the basis of the blocks' surfaces, where the marks from the pounding are seen as more or less round-to-oval crush marks in the rock. Hammerstones correspond to that edge shape.

Our finds of tools were very few, but those found were hammerstones. Three were encountered. The smallest was of a grey, tuff-like rock similar to pumice and fit for one hand. On two opposite sides, the stone was hammered out to form hollows. That gave a good grip for the fingers (Figure 34). I cannot say from where the stone had been extracted, but similar stones are found in the Vilcanota River (Sven Ahlgren, personal communication, 1989). Its surface was rough and did not correspond to

Figure 31.
Block with preparation marks forming a rounded pattern. Block no. 101, the southern rock-slide area. Facing SE.

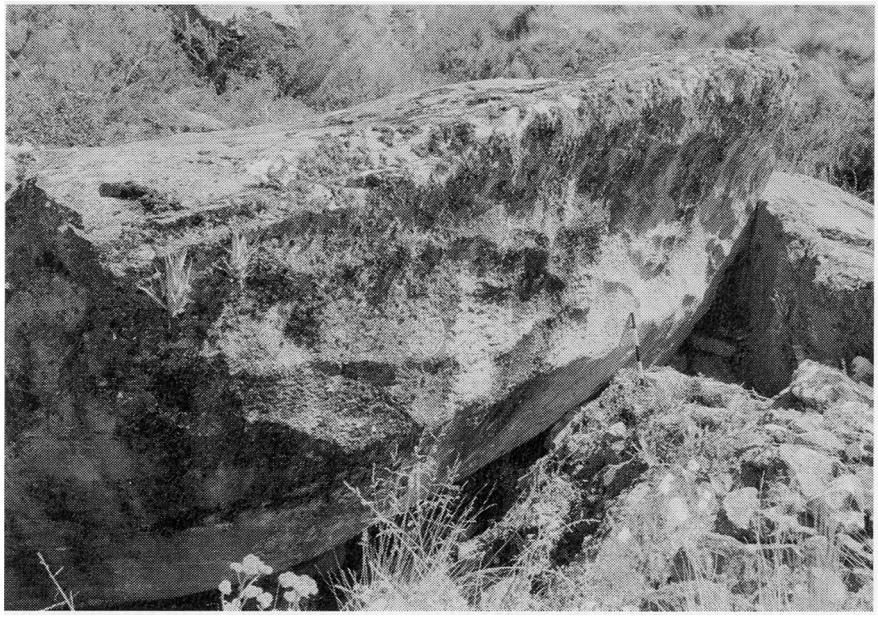


Figure 32.
Block-side with preparation marks tending towards a rectangular pattern. Block no. 102, the southern rock-slide area. Facing WSW.

that of a common river cobble, but, on the other hand, I do not know of another source of this rock in the district. It lay on the surface in the southern rock-slide area, within the actual rock-slide between two ramps (for ramps, see section 2.4 on "Transportation"). A second hammerstone lay in the trench opened up between the two blocks at test-point 6 described above. It was of Allinyana material and measured 16×13×9 cm (Figure 35). The hammerstone was not much used before being left on the site, since its hammering marks are only slight. A third hammerstone

Figure 33.
Block with preparation forming vertical furrows on its short side. Block no. 101, the southern rock-slide area. Facing ENE.

of about the same size as the one from test-point 6 was noted on the surface of the Kachiqhata slope, close to the north-western corner of the workshop terrace mentioned above. It was a water-rolled, river cobble of quartz and was left by me at the site. The stoneworkers possibly made use of other tools with a rounded edge that were not hammerstones, but at least so far we have found none.

Although hammerstones were used in the stonework, our finds are very scarce. It may be added here that Protzen reported sixteen hammerstones at Kachiqhata, twelve of which were certain (personal communications, 1983 and 1986). Outwater's statement (1959:28; 1978:584), that hammerstones lie in great quantity at a work-place by the Vilcanota River, is erroneous. The place he refers to has an abundance of water-rolled cobbles on the ground but that is due exclusively to natural causes. The river has changed its course at this spot, leaving a former segment of the river-bed exposed, and the cobbles show no use-wear at all.

We noted one single flake that showed signs of having been struck with a tool that had a different edge shape from that of a hammerstone. It lay in the trench excavated in between the blocks at test-point 6. The flake has a mark on its platform that corresponds to the blow of a tool with a straight edge, as opposed to a rounded edge. The edge of the tool was been 5 cm long. The shape of the mark corresponds to that formed by the strike of a *kantjärn* (literally, "edge iron"), a tool used by stonemasons in the present century in Bohuslän, Sweden. The *kantjärn* tool has similarities with some small sledgehammers and with some chisels, and it can be said to belong to a class between the two. As compared with a

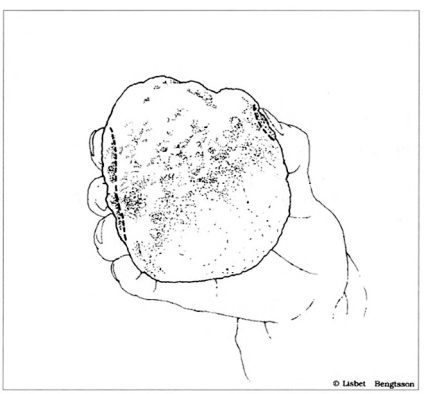


Figure 34.
Hammerstone of a grey, tuff-like rock hollowed out on each side to give a better grip. The southern rock-slide area.

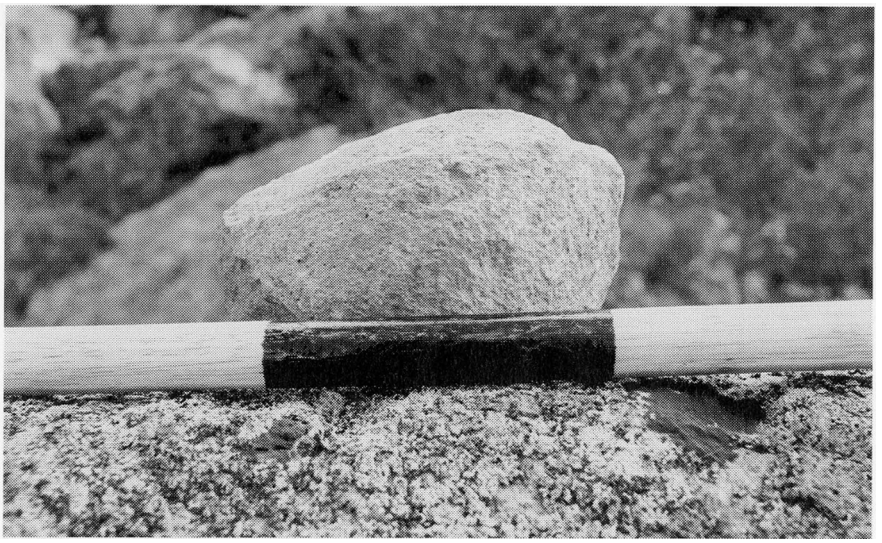


Figure 35.
Hammerstone of Allinyana rock from the trench at test-point 6. The western rock-slide area.

chisel, it has a wider edge, and the edge is not sharp but blunt. The edge of the *kantjärn* tool is about 1–1.5 cm wide. This tool is used in Bohuslän for blowing off flakes from the edges of stones and blocks. Whether the single case from the rock-slide areas of Kachiqhata represents the actual use of a *kantjärn* tool (although of some other material than iron) can be evaluated only if more flakes with similar marks are recovered or if any such tool is found in the rock-slide areas in a context related to the vestiges of ancient stonework.

2.4 Transportation

Layout

The distance between the rock-slide areas and the building site in the temple area is about 3–4 km as the crow flies (Figure 8). That was the distance to be covered in the transportation of building blocks. It included a height difference of roughly 400–800 m between the point of extraction and the valley floor. For that stretch, most of the transportation was downhill. An exception is the northern rock-slide area, from where some of the blocks were taken slightly uphill to a certain point before the subsequent downhill transportation. Once on the valley floor, the blocks were moved on almost flat ground to the river bank, taken across the river and then over the rest of the valley floor, which was mostly slightly uphill, and finally uphill on the opposite mountain slope to the temple area.

In general, ramps were built as inclined planes in the actual rock-slides and led out of them (Figure 36). The ramps converge by degrees. In the continuation, they converge into three trails, which in turn converge into one main transportation trail leading obliquely down the Kachiqhata slope. For the steepest stretches, chutes were used, both in and between the rock-slide areas and for the last stretch downhill to the valley floor (Figure 37). On the valley floor, the blocks left during transportation are themselves vestiges of the route used. On the other side of the valley floor, a ramp was built obliquely up the slope of the Bandolista mountain to enter the temple area (Figure 38).

The layout in the western rock-slide area differs from those in the southern and northern areas in that it is not as well defined and systematically made in all parts. This may be due to its location further away from the building site and to the fact that it was, as it seems, exploited only during the final stage of the labour process.

There are chutes in a natural depression between the western rock-slide area, on the one hand, and the southern and northern areas on the other (Figure 8). These chutes were identified only late in our study. They explain the mixed character of the blocks on the ramps in the northern rock-slide area. These blocks come not only from the northern rock-slide area itself but also from the western and southern rock-slide areas.

Installations

I distinguish between three types of installations: ramps, trails and chutes. The chutes are not necessarily installations in the proper sense

Figure 36.
The southern rock-slide area with the actual rock-slide to the right in the picture, and with ramps leading out of it.

but may be natural features taken advantage of for the transportation. They are presented here, because they form a pattern, together with the ramps and trails. All in all, I have recorded twenty-two ramps, six trails and fifteen chutes. All three types of installations were built or used for the purpose of moving blocks. On this point, I disagree with Protzen, who calls the trails and ramps access roads (1985:162, 1986:80). It was certainly a minor problem to reach the quarries by walking and climbing without such installations than to transport the blocks out of the quarries without them.

The *ramps* are inclined planes, which have quite clear beginnings or endings. Most of them are in the rock-slide areas, but one which at a certain point splits into two is located by the temple area and leads to it from the valley floor. I shall call this one the temple ramp. The ramps differ somewhat in their build-up, according to their location. The ones in the actual rock-slide of the western area are more irregular than those in the actual rock-slides of the southern and northern areas. This may be due to the amount and the spread of the large boulders in the western area. My impression is also that the work was more hastily executed in the western rock-slide area.

The sections of ramps within the actual rock-slides are constructed of stones and boulders from the rock-slides themselves. Flakes sometimes lie on the surface but may be the result of the preparation of blocks on the ramps, blocks that had already been moved out of the area. Such flakes consequently do not necessarily form part of the construction of the ramps. Outside the actual rock-slides, finer material was used in the construction, together with the stones and boulders. Visual inspection

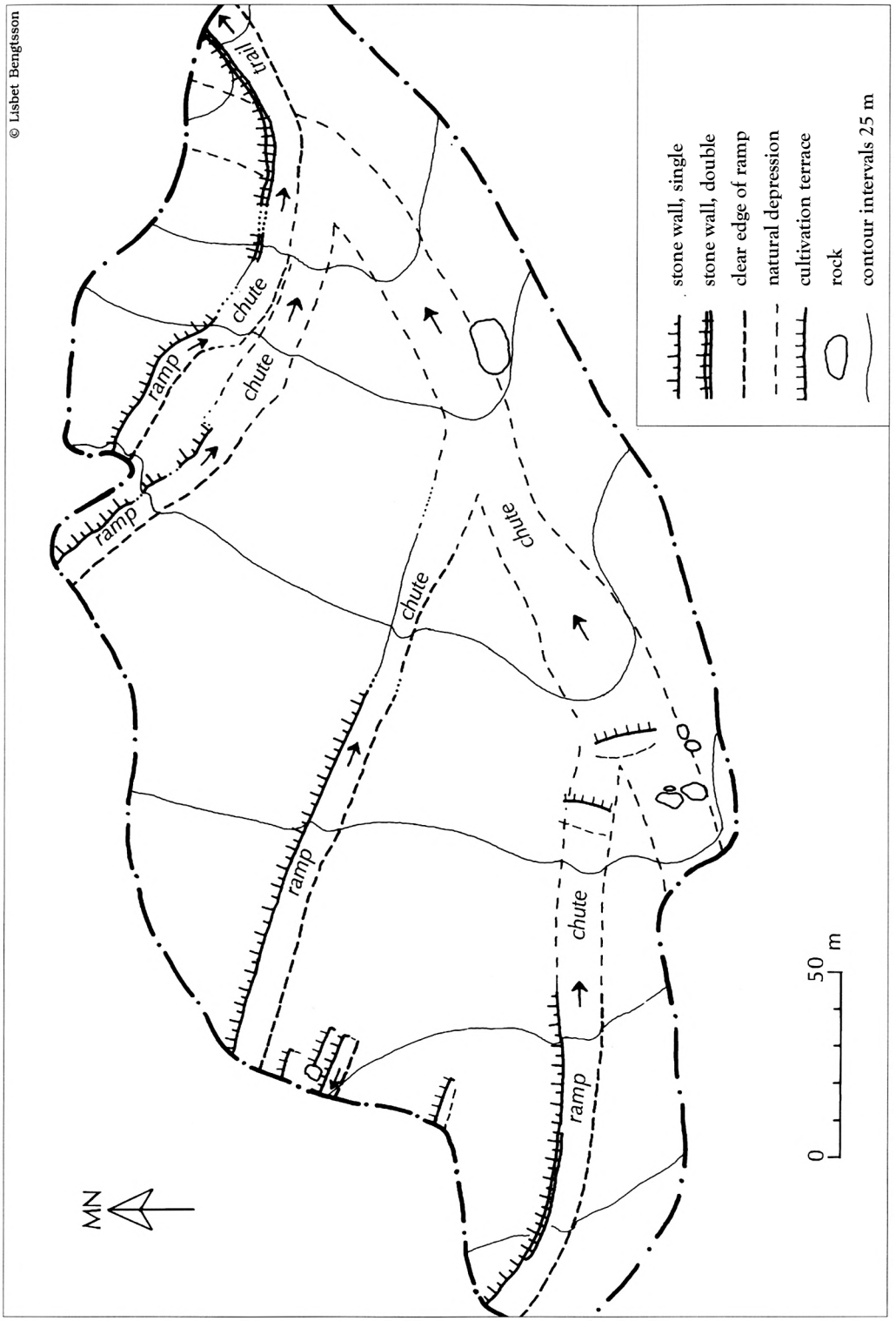


Figure 37.
Four chutes leading from ramps and into a trail. The southern rock-slide area.

Figure 38.
The temple ramp leading from the valley floor uphill to the temple area. The block named Inkaqonqorina, which lies in a low part of the ramp, is marked with arrows. Facing NE.

showed that the finer material used as a filling corresponded to the soil on the slopes on which they were built. The stones and boulders for these segments are mostly of local material. As for the southern rock-slide area, it is notable that material was also taken from the actual rock-slide to be used for segments further down the slope. No material was moved from the outside and into the actual rock-slides, as far as we have been able to determine.

The ramps are built onto the mountainside and, where measured in the rock-slide areas, are 6–9 m broad (Figure 39). They have walls of stones on their lower sides. In general, the walls abut, in order to stabilize the ramp construction itself. One reason for the abutment was probably to enable the ramps to withstand the destabilizing effects of the weight and the vibrations caused by people and blocks moving on top of them.

The walls were built in two different ways. One way was to make the wall abut evenly towards the top (Figure 40). The other was to make the wall incline only slightly but at the same time to make one or more ledges in it (Figure 41). The ledges must in some instances have facilitated the construction. In erecting a high wall, the masons could climb from the ground onto a ledge and thus stand on it while working upwards. Yet that was probably not the only reason for making ledges. Some ledges are so narrow that an adult has to tread on them with the feet sideways, and this posture makes any work both difficult and risky. Another point is that, if they were primarily built to serve as scaffolds, one would expect them to be present in all high-wall segments and not in low walls. There is no consistency in this respect. There are high-wall segments without ledges, and there are even examples of the two ways being used for different segments of the same ramp wall, although the segments are of roughly the same height. My interpretation is therefore

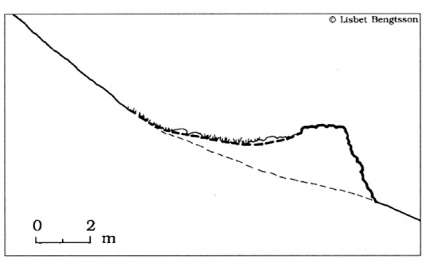
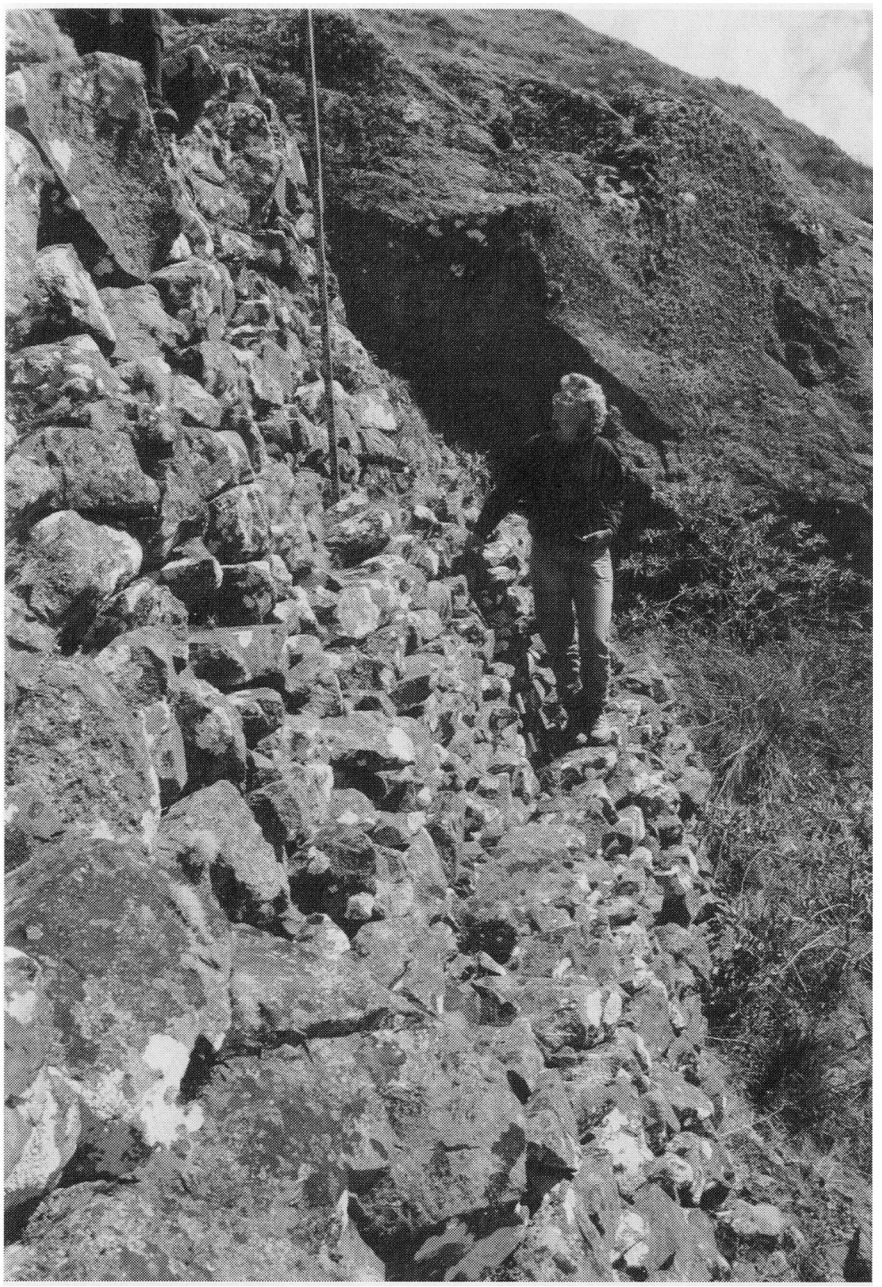


Figure 39.
The ramps were built onto the mountainside, with an abutting wall. In many cases, the surface of the ramp is concave. The southern rock-slide area. Sketch based on photograph.

that it was in part a matter of taste among the masons, which procedure was followed.

Because the temple-ramp wall has collapsed in some places, it is possible to study its build-up. In the segment closest to the valley floor, there is one single wall-layer. Most of the ramp has two wall-layers (Figure 42).



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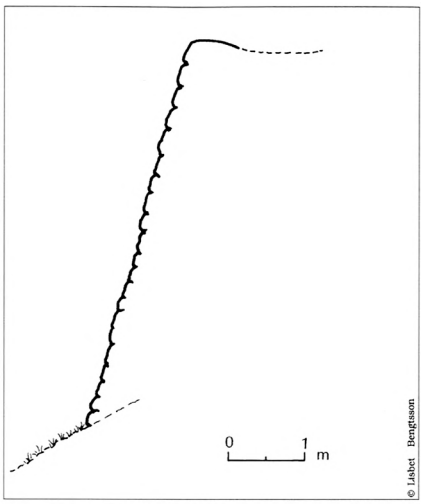
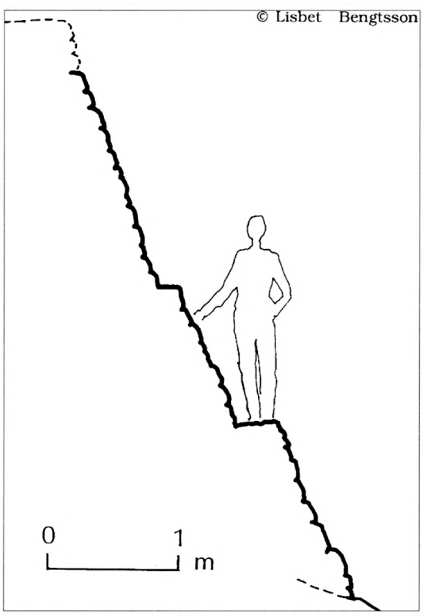


Figure 40.
Ramp wall built with an even inclination. The temple ramp. The size of each stone has not been measured.

Figure 41 *a-b*.
Ramp wall built with ledges. The southern rock-slide area.



(*b*)

Figure 42.
Two wall layers were used for most of the temple ramp. Facing SE.

Close to the entrance to the temple area, there are even three layers distinguishable in the mightier of the two ramp ends (Figures 43 and 44). The reason for building the wall with more than one layer was most probably to stabilize the construction. At the entrance to the temple area, the ramp wall is exceptionally high, reaching about 15 m. Where three layers were used and can be studied, the inner wall has a face and is built with large stones laid horizontally with their long sides forming the face. The majority of the stones are rectangular, rudimentarily cut, and 17–41 cm long. They are set in a mortar of yellow, clayey silt mixed with grass. The clayey silt is not the soil of the mountainside and had to be brought from elsewhere. In this wall, there are some stones protruding, which have been separately set with their short ends in the wall. Some of them are natural, others are rudimentarily cut. My interpretation is that they were set into the wall primarily to form a bond between the inner wall and the next layer. Yet another reason for placing them in the wall may have been to make them serve as steps, which were used as scaffolds during the construction of the wall. Outside this inner wall was a filling of large stones, 18–27 cm long, most of which are natural and lie in no sort of order. These stones are also set in a mortar of yellow, clayey silt mixed with grass. The outermost layer is built with natural, large stones, most of which are rounded and have their short ends forming the face of the wall. They are somewhat larger than the stones in the inner layers and measure 37–52 cm in length. They were most probably brought from the Vilcanota River. Quite clearly, the construction of this ramp involved a major effort.

Figure 43.
Collapsed segment of the temple-ramp wall. Three wall layers can be distinguished. Facing N.

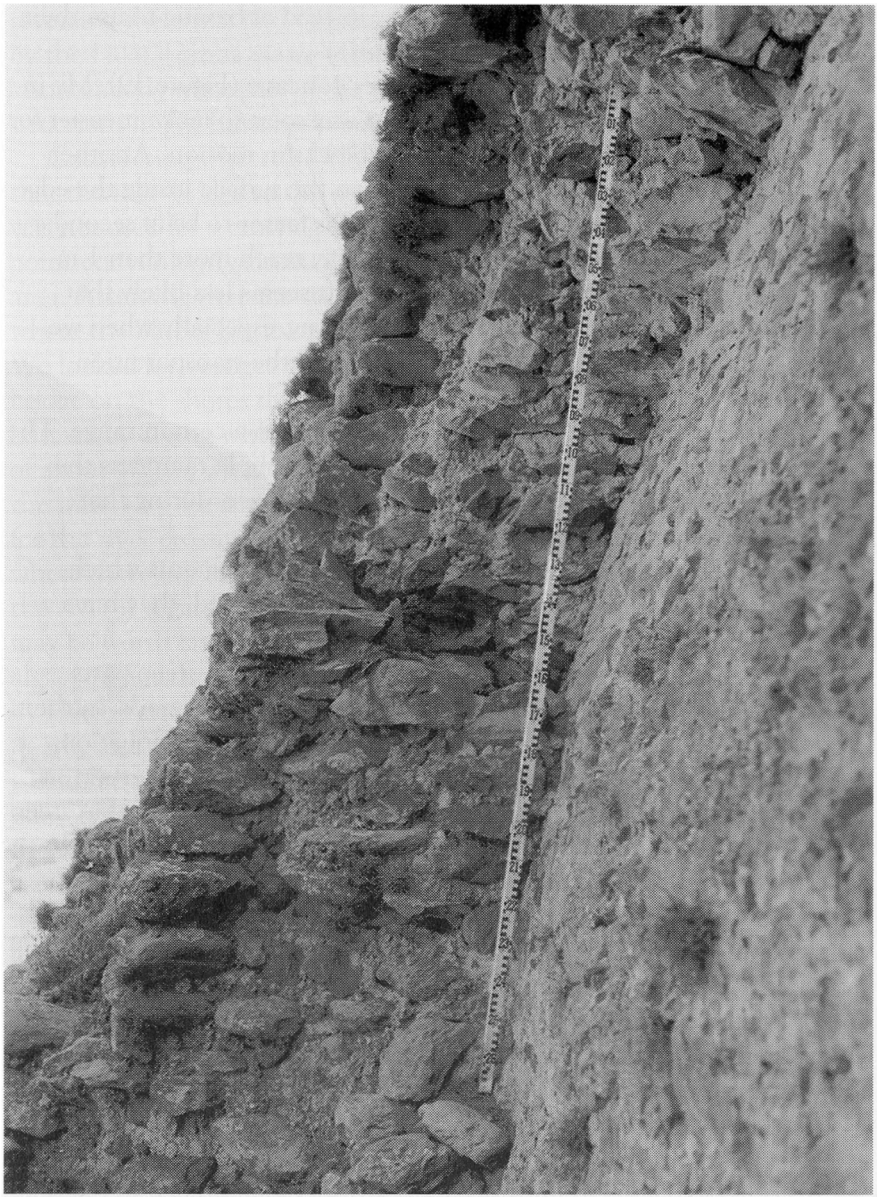


Figure 44.
Collapsed segment of the temple-ramp wall. Detail showing the three wall layers. Facing NW.

A clue as to how minor loads of construction material might be carried, such as soil and stones for the ramps and trails, is given in a section of Betanzos' book dealing with the repair and canalization of streams in Cusco. The Inka ruler Inka Yupanki (that is, Pachakuti Inka Yupanki) had special pieces of cloth made to be used in the work and also to be stored in Cusco for future constructions. The pieces of cloth were to be coarse and thick, made of hemp, and with cords two spans long (about 40 cm) at their corners, with which they could be tied round the neck or in some other way by the workers (Figure 45). In these pieces of cloth, they

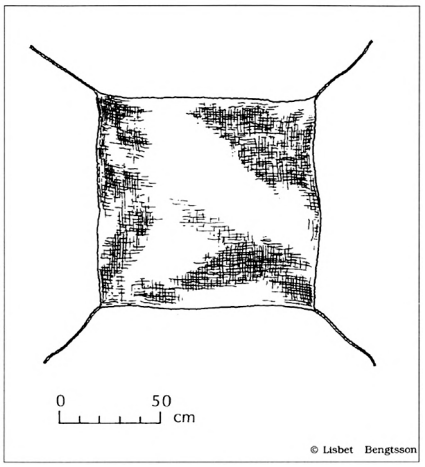


Figure 45.
A piece of cloth for carrying soil and stones during construction work. My interpretation of Betanzos' description.

were to carry the soil and stones necessary, instead of having to use their own cloths (Betanzos 1987:61 [1551 :Ch. 13]).

The surface of the ramps is in many cases concave (Figure 39). My interpretation is that a ramp was built in that way so as to make it easier for the workers to control the direction of the blocks in motion. Another possibility would be that the finer material on the surface inside the edge of the wall has been washed away. I believe this factor to be of secondary importance, because the surface of the wall may reach more than 1 m above the lowest point on the ramp's surface. It seems less likely that such an amount of material has been eroded away, especially when we take into account the fact that other segments of the transportation route do not show signs of such major erosion.

The inclinations of the ramp surfaces vary within a certain range. The stretches measured have an angle of 7–21^{g}.[1] The temple ramp has the slightest inclination, and that is most probably because, during that stretch, the blocks had to be moved uphill.

The *trails* are similar in construction to the ramp segments which were built outside the actual rock-slides. Where measured, they have a width of 6–7 m and an inclination of 8–20^{g}.

As mentioned, *chutes* were used to move blocks down steep parts. Their widths are about the same as those of the ramps and trails. In their uppermost parts, they are in most cases actually built as continuations of a ramp or trail but with a markedly steeper inclination. At a certain point, no further construction was done. The chutes were placed in steep parts of the terrain and, for many chutes, natural depressions down the slope were taken advantage of. At least for one chute, the natural depression was accentuated, namely for one of the chutes leading down to the valley floor. The workers deliberately took soil from it and placed the soil alongside the chute as an embankment. Chutes have an inclination of 32–45^{g} where measured. There are even steeper parts, but they were difficult to measure with the methods we had available, that is, by walking and by using a clinometer.

The valley floor

On the valley floor, there are no trails visible above ground that might have been used for the transportation of building blocks. One very special transportation stretch was the Vilcanota River, which had to be crossed. The course of the river has not been left unaltered since inka times. At the end of the 17th century, the Centeno family, at the time owners of the Huatabamba (later Compone) estate, had the waters directed towards the Kachiqhata side by building a breakwater, in that way augmenting the estate's cultivable land. Years later, the Bethlehemites started a breakwater from the Kachiqhata side of the river, in that way

reversing the effect and causing the waters to flood lands then cultivated by the Huatabamba estate (Glave & Remy 1983:216, 294). I do not know exactly what part of the river was affected or what effects the constructions might have had upon the later course of the river.

Considering where the blocks lie on the valley floor, it is quite clear that the inka bridge to the south-east of the village of Ollantaytambo was not used for a crossing (Figure 8). Instead, the river was crossed at a point conveniently situated between the rock-slide areas and the temple area. Assuming that the river course has not been affected in the section where the blocks lie, the relevant stretch for a crossing is quite limited. We looked for vestiges of foundations or pylons for the abutment of a bridge on the shores there but found none. We also searched the river bottom by diving with snorkel and goggles. This was done along a stretch of about 400 m, which covered the possible points of crossing, including the waters by the island just downstream. No remains of any installations for the river crossing could be confirmed. An inclined plane at a point where there is a low wall leading to the water on the Kachiqhata side of the river is regarded as being natural, but in any future investigation it may be worth checking it again at some other time of the year, when the algae are not thriving. There is no reason to believe that the statement by Harth-terré (1965:162), that the blocks were taken to the island nearby and from there to the other side of the river, is correct, unless the island has moved down river over time. The island lies off the point or points of crossing, if one judges from the position of the blocks close to the river (Figure 8).

For the remaining parts of the valley floor, we chose two spots in which to make excavations (test-points 1 and 2). The aim was to search for vestiges of any trails or bedding used for the transportation.

The spot for test-point 1 was chosen because three large blocks lie in a row there. Their location within a cultivated field, their size and the fact that they form a row seemed to guarantee that they had not been moved since their original transportation. Moreover, they lie in their longitudinal direction, just as blocks generally do on ramps and trails. This was considered an exceptionally good spot to search for vestiges of any trail or bedding used for the transportation of large blocks on the valley floor. A fourth, large block lay totally buried in the ground, and a small part of its upper surface was only discovered in a furrow. The fact that it was so deeply buried supported the idea that that block lay *in situ* as well. My interpretation as to why it lay so deeply buried is that the lynchet, which today is located just uphill from the block, earlier ran in the same direction but just downhill from the block instead. The soil thus accumulated by the block and along the rest of the field boundary through soil creep.

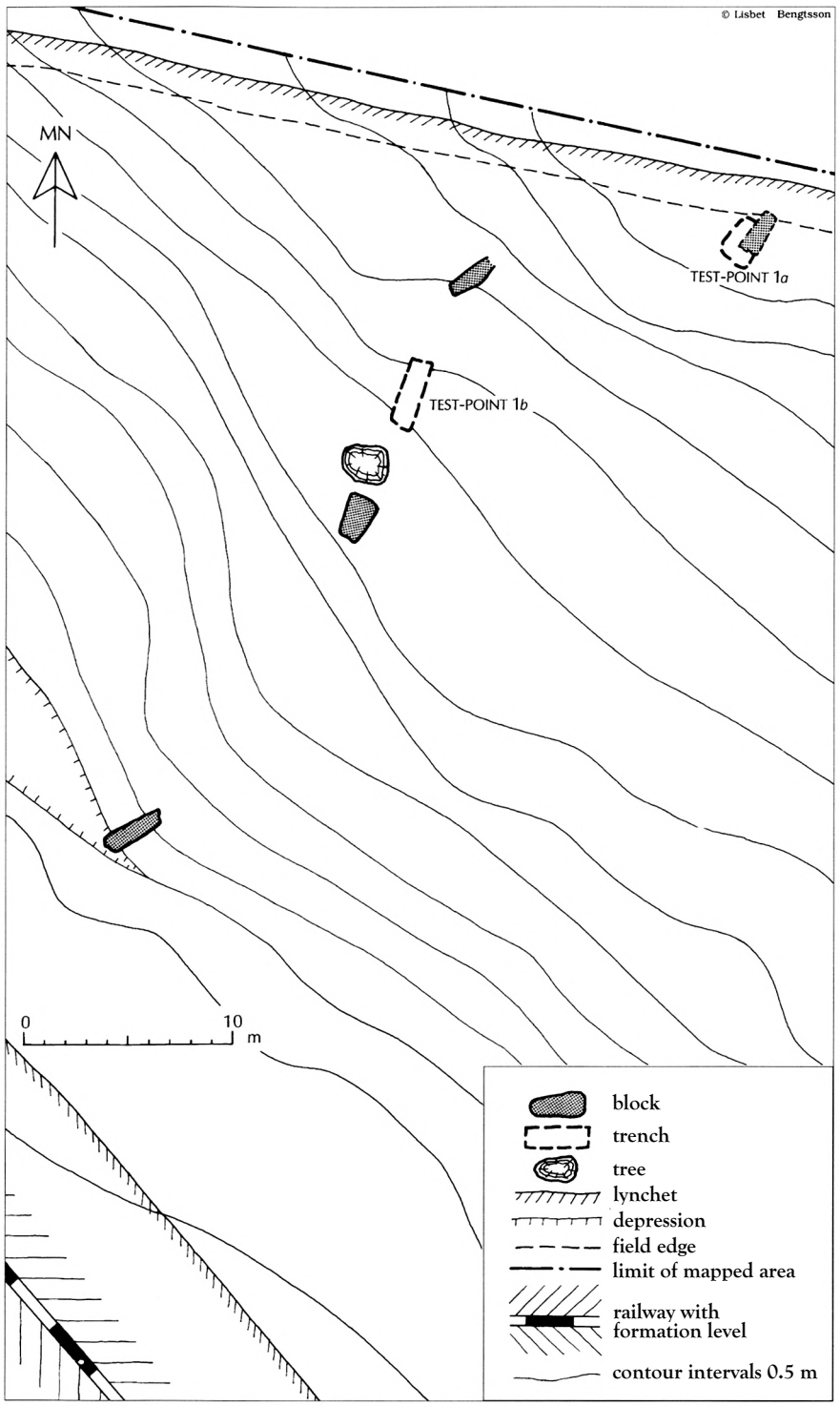


Figure 46.
Three large blocks lie in a row in a cultivated field on the valley floor. A fourth block was found buried close to the field boundary. A trench was opened by one of the blocks in the cultivated field to search for vestiges of a trail or bedding, and another was opened between two of the other blocks. Test-point 1.

Test-point 1 included two trenches. One of them (1*a*) was excavated just by the buried block, the other (1*b*) was excavated between two of the other blocks in the same field (Figure 46).

We found no vestiges of transportation facilities in the two trenches. There were no constructions and no visible vestiges of any special bedding. The composition of the soil was what could be expected for the soil on the valley floor. In trench 1*a*, the composition and colour of the soil were a yellowish-brown, sandy silt with humus, gravel and stones to a depth of about 1.2 m, which included a depth of about 0.4 m below the bottom surface of the block. That means that the soil was similar in colour, humus content and grain fractions to the soil elsewhere in other cultivated fields nearby. Some stones lay scattered at a depth of 0.3 m below the bottom surface of the block. They did not form a stone-packing, and I interpret them as an incipient clearance cairn, that is, a repository for unwanted stones from the field. Deeper down, that is, well below the bottom of the block, there were layers of yellow sand and clay. Our interpretation is that these layers represent sediments deposited in the Vilcanota River at a more or less remote time, when the river had its course there. The deepest part of the trench reached 1.6 m below ground level. In trench 1*b*, the surface of any trail in the ground was expected to be no deeper than 0–0.4 m. The trench was excavated to a depth of 0.7–0.8 m, but no special features could be distinguished. The soil was similar to the soil in trench la.

The other test-point on the valley floor, test-point 2, was located by yet another large block (block no. 48). This block is one of a cluster of blocks lying close to the beginning of the temple ramp (Figure 47). The site is called *Rumira*, quite certainly standing for *Rumiraq*, which means "where there are still stones" in Quechua. It may also refer to the fact that the "stones are still on their way" (to the construction site) (Clodoaldo Soto Ruiz, personal communication, Champaign, 1992). The block lay half-buried, with one end in a lynchet and the other end outside the field boundary (Figure 48). This indicated that it had been lying on the same spot for a very long time, probably since it was left during transportation. As the size and weight of the block became clear, they supported its location *in situ* even more. Since it lay half-buried, I considered the conditions to be especially good for studying a former ground surface and any trail or bedding used for its transportation. We excavated a trench along one of its long sides and one of its short sides. The depth of the trench was 0–1.8 m and reached 0.1–0.5 m below the bottom surface of the block (Figure 49). The soil was similar to the soil at test-point 1, with a yellowish-brown, sandy silt with humus, gravel and stones. At a depth of 0.2–04 m below the bottom surface of the block, a layer of yellow clay began, a layer which was probably deposited when the Vilcanota river once ran here.

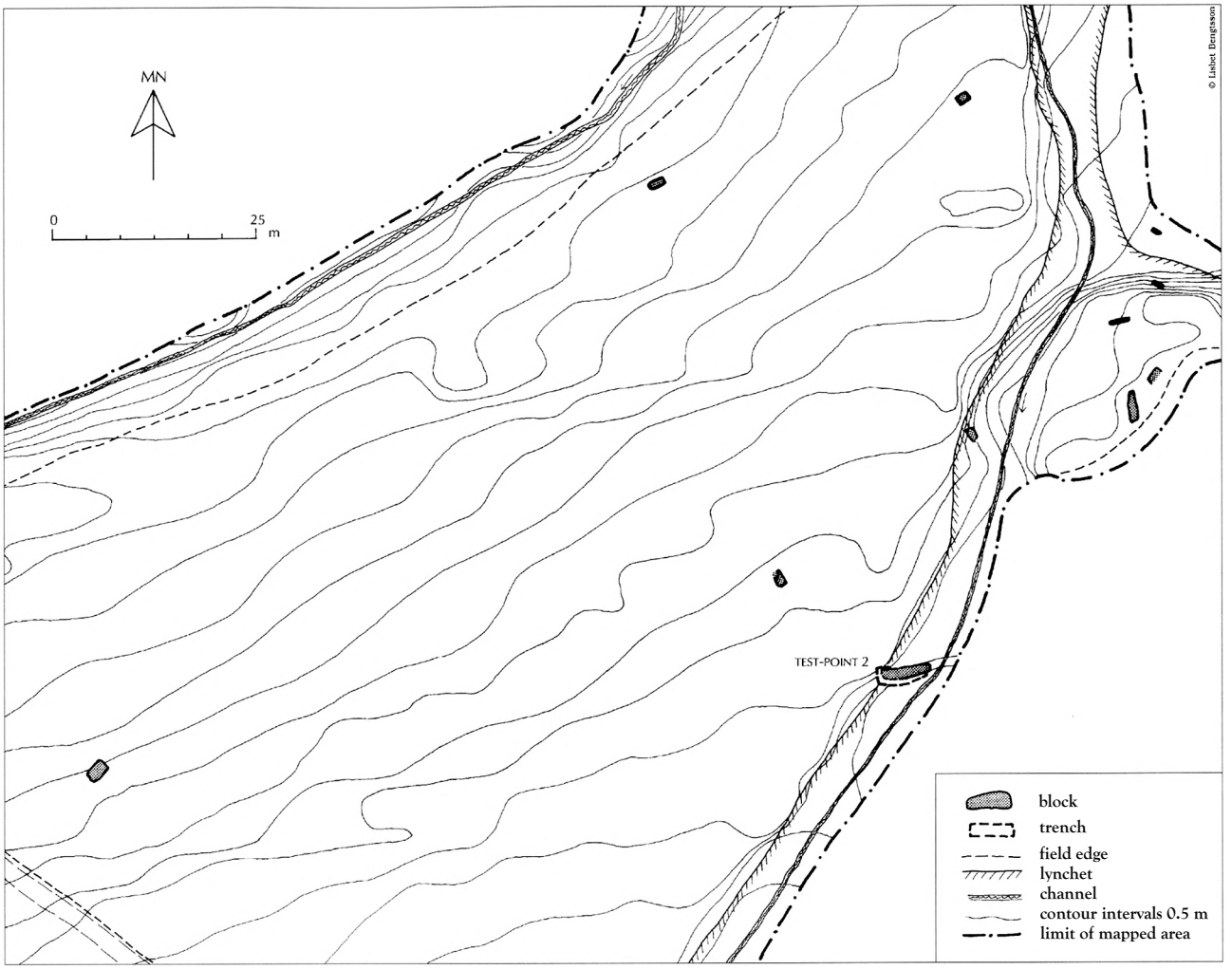


Figure 47.
Cluster of blocks on the valley floor, close to the beginning of the temple ramp. Test-point 2 is by block no. 48.

Some stones lay at the bottom le,vel of the block. I interpret them as an incipient clearance cairn and not as vestiges of any trail or bedding for the transportation. They did not form a stone-packing beneath the block itself.

My conclusion from the excavations at test-points 1 and 2 is that, for the valley floor, no installations were built for the transportation and the ground was in no way altered for the purpose of transporting blocks.

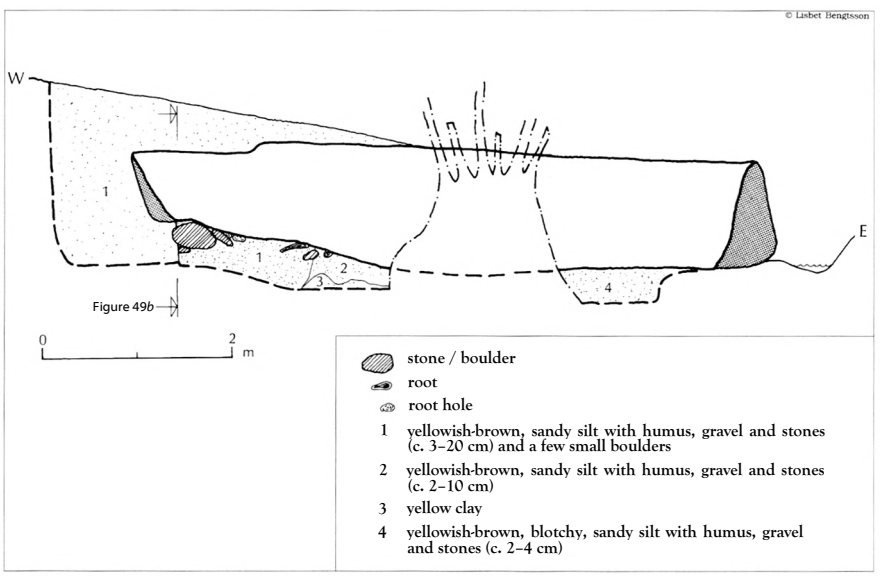
A crucial point along the transportation route, as it appears today, is between the valley floor and the beginning of the temple ramp. Terrace walls form an obstacle between the two. We do not know whether the terraces in their present form were built before or after the transportation, only that they certainly have all the characteristics of inka imperial origin. A complicating factor is the modern motor road, which obstructs

part of the evidence. One possibility is that inclined planes were built from one terrace level to the next, close to the house today known as Varela's. There is one inclined plane today, between the house and the motor road. Another but simpler plane has been built close by to a lower level. They are recent but may suggest a precedent. In the present state of our knowledge, I am inclined to prefer another alternative: the terraces at this place were not yet built, when the transportation took place, and the vestiges of the connection point between the valley floor and the temple ramp were covered or destroyed by the later construction of both the terraces and the motor road.

Figure 48.
The block at test-point 2 lay half-buried in a lynchet. After excavation. Block no. 48, the valley floor. Facing E.

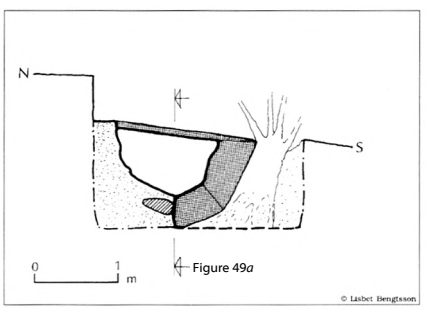
Transportation techniques

The information we have from the ancient, written sources is hardly exhaustive. The means of transportation mentioned include man-power and ropes made of hides, hemp and nerves. We can assume that the information is correct and that levers were also used, although we have no archaeological evidence of ropes or levers from Ollantaytambo. The protruding knobs that are common on blocks in the temple area (see the thin blocks inserted in the front temple wall, Figure 66) are considered by some to have been used to fasten the ropes around the blocks when transported (for example, von Hagen 1961:147; Gibaja 1982*a*:Ch. 6.05). I cannot find that this is a reasonable explanation for the knobs. Many of them do not have a shape suitable for keeping the ropes from sliding but are somewhat pointed. Moreover, knobs on blocks in the rock-slide areas



(*a*)

Figure 49 *a-b*.
Profiles of the trench at test-point 2. Block no. 48, the valley floor.



(*b*)

and along the transportation route are extremely rare, not to say non-existent. Of the several hundred blocks, only a couple show features that could possibly be knobs that had been begun but were in any case left unfinished.

What is clear at Ollantaytambo is that great efforts were made to prepare the ground for transportation, both on the slope of Kachiqhata and on the slope of the Bandolista mountain, although not on the valley floor. Blocks were moved in their longitudinal directions and most of them, if not all, were probably moved one by one. On the Kachiqhata slope, care was taken to make both ramps and trails inclined, to facilitate the downhill movement. At the same time, care was taken not to make them too inclined, certainly to secure control over the speed and direction of the blocks. For some stretches, the ramp and trail surfaces were made concave to further facilitate the control. In a chute, minimal control was needed, and the block was probably slowly pushed over the edge of the ramp or trail which led into it and then allowed to find its way downhill on its own with as little aid of man as possible. Judging from visual inspection, the chutes were in general not given any special bedding. For the long, north-western chute leading down to the valley floor, the stones with a laminated structure, apparently shale, that have come loose from the underlying bedrock and lie on the ground must have constituted a convenient surface. Even today, the ground is very slippery. Soil has accumulated on the valley floor below the chute and that soil also contains flakes. It seems that flakes from the preparation of blocks were placed in the chute to further diminish the friction with the ground there.

One of the many problems must have been to keep the blocks from getting caught in the ground at their fronts. When a block got caught, the workers would make an effort to get it started again, at the same time making sure that they did not stand in its way. Those moments must have been among the most dangerous ones. One block along the route seems to have been left in such a position. It is still lying in a chute leading down to the valley floor (Figure 50).

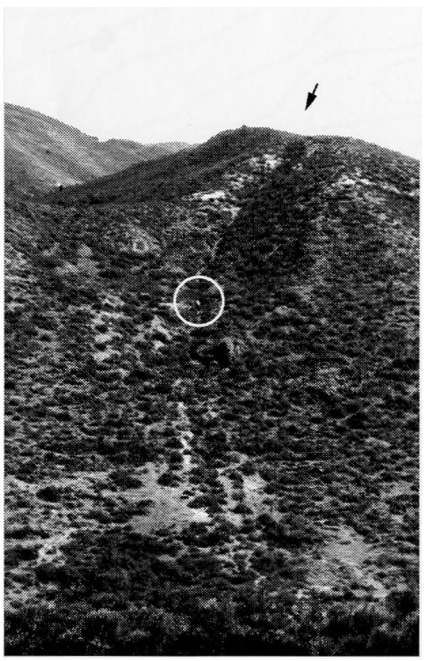


Figure 50.
Block left in one of the chutes leading down to the valley floor.

As for the river crossing, we have negative information rather than positive, that is, we have no evidence of an installation for the crossing, such as a bridge. Pardo (1946:53) put forward the suggestion that the waters of the Vilcanota were diverted from one side of the island—close to where the blocks still lie—and to the other side (Figure 8). This was done so as to move the blocks on dry land to the island. Then the waters were diverted back on the one side of the island, and the rest of the river was crossed. I cannot agree with Pardo here. As mentioned above, the island is not located right in between the blocks that lie on both sides of the river. On the contrary, the island is somewhat downstream from them. There is no indication that the island was used at all. I am instead

suggesting that the blocks were moved through the water. The blocks lie in the fields on both sides of the river, and the river is comparably wide and shallow here. The water itself would not have constituted much of a hindrance for the blocks, even though the workers might have found it a less convenient environment to work in. The weight of the blocks must have been felt less in the water than on dry land, and the friction on the ground must also have been less. The real problem was the current. If we assume that the blocks were moved through the river, that was certainly done in the dry season. At that time of the year, the water is rather low, and the current is comparatively weak. The fact that the blocks do not form a single row on both sides of the river indicates that more than one point of crossing was used. This supports the idea that no especially constructed installation, such as a bridge, was used.

For the rest of the valley floor, it seems that the blocks were moved on the natural ground. We found no vestiges of trails there, and we found no vestiges of any special bedding, such as pebbles, clay or organic matter. No rollers were found, although it is said that such devices were used by the inkas (for example, Astete 1952; von Hagen 1961:147, 149). If the blocks were moved directly on the ground on the valley floor, friction must have constituted a major problem, especially uphill. Striation marks on the blocks' surfaces have been considered to be drag marks by Protzen and have been used as evidence that the blocks were actually dragged on the ground (1993:176–178). Protzen's arguments and his photograph of a block in the temple area seem convincing, but there are some complicating factors. A consequence of our observations must be that the question of whether and under what circumstances drag marks form on blocks under transportation is still unsettled.

One complicating factor, already noted by Protzen, in judging striation marks to be drag marks, is that striation marks often occur on more than one block face. If they are due to dragging, these blocks must have been banked during the transportation. Because of the weight of many blocks, I find it highly unlikely that they would tumble down chutes and thereby change their positions. If drag marks did form on the blocks, we should expect them on all the bottom surfaces, as they now lie, regardless of whether they are present on other block faces as well. The block at test-point 1*a* has striation marks on its upper surface (Figure 51) but lacks them on its bottom surface, at least on the portion that could be scrutinized, which was about 1 m×0.20 m. If the striation marks on its upper surface are really drag marks, then the block would have been banked upside down on the same spot where it now lies. Otherwise, new drag marks would have formed on its present bottom surface.

We can presume that any drag marks would be more accentuated on heavier blocks than on lighter ones. The block at test-point 2 is certainly very heavy. If we use a density measurement of 2.7 for the granite, then 1

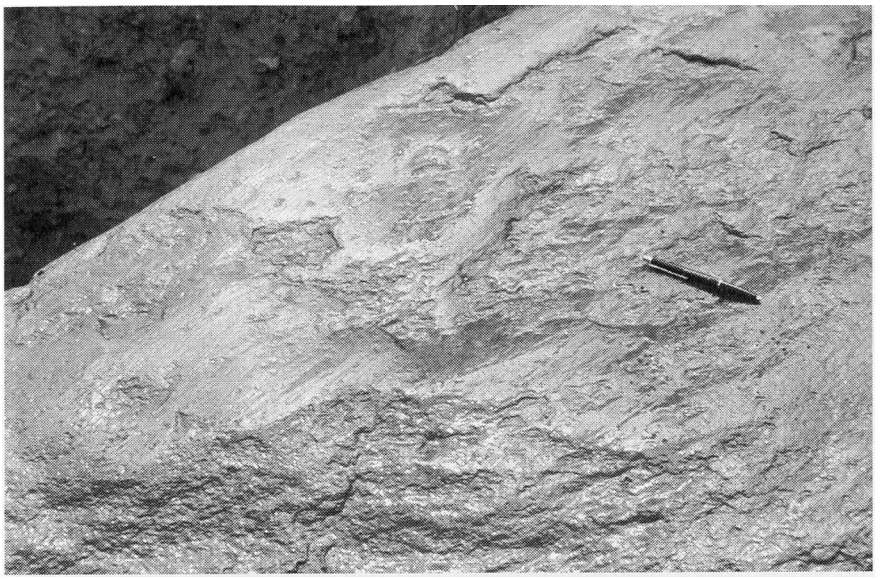


Figure 51.
Striations on the upper surface of the block at test-point 1 a. The striations can be discerned as more or less parallel marks from the upper right to the lower left in the picture. The valley floor.

m³ weighs 2,700 kg. The total weight of this particular block would then be about 30 tons. We were able to check about 2 m×0.5 m of the block's bottom surface. This block does have striation marks on its bottom surface. One requirement is thereby fulfilled for classifying them as drag marks. On the other hand, the block has striation marks on its upper surface as well, so once again it is difficult to explain them as drag marks, considering the weight of the block and the small likelihood that it was banked during transportation.

Yet another block could be checked. Test-point 9 was located by a block popularly called Inkaqonqorina, in order to study any vestiges of the transportation uphill on the temple ramp (Figures 38 and 52). It lies close to the beginning of the temple ramp, in a section that has been used for a motor road. Attempts to move the block to make the road straight were in vain. As it is, the road makes a bend round the block (Figure 53). The block (block no. 41) is the heaviest one left during transportation, weighing an estimated 70 tons.[2] It has striation marks along the upper edge of one of its short sides. About 4×1.5 m of the bottom surface under one of its short sides was checked, and 2.6×0.5 m under one of its long sides. No striation marks were noted on the bottom surface. Quite clearly then, even extremely heavy blocks could be moved without any drag marks forming. A very interesting feature was noted on the block's bottom surface, namely a relief forming an angle (Figures 54 and 55). Reliefs are uncommon on fine masonry. If it was meant to be shown on a façade, it is the more surprising to find it on a bottom surface, where the risk of being damaged during the transportation seems greatest. Contrary to what might be expected, even the edge of the relief was intact and showed no signs of damage.

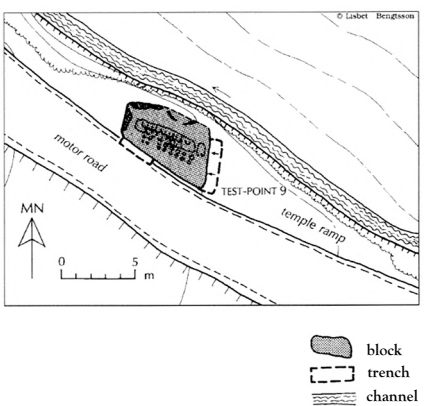


Figure 52.
Location of the Inkaqonqorina block by the motor road. Our trenches are marked. Test-point 9, block no. 41. The temple ramp.

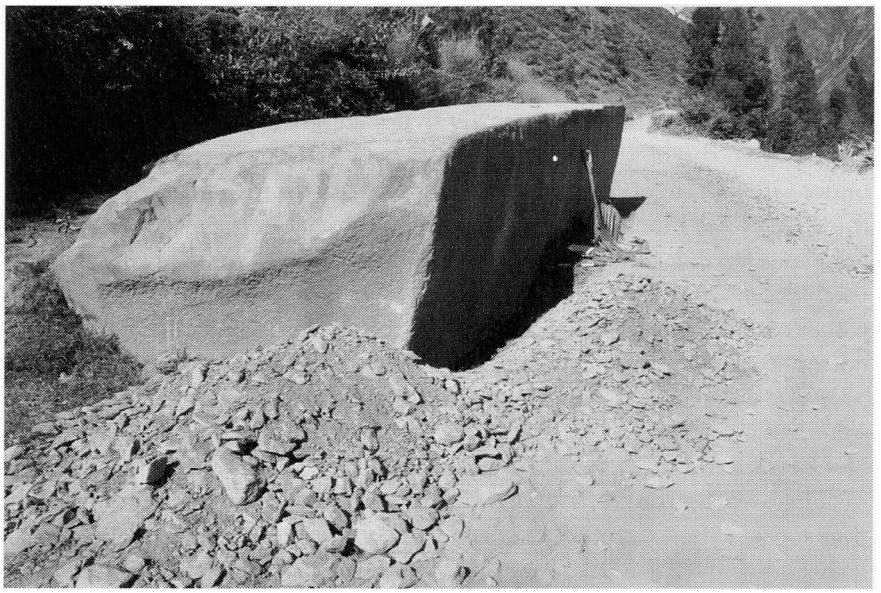


Figure 53.
The Inkaqonqorina block after opening a trench along part of its south-western long side. The motor road between Ollantaytambo and Ch'illca makes a bend round the block. The block has been damaged on its western short side in later times, probably in a lorry crash. Test-point 9, block no. 41. The temple ramp. Facing ENE.

We had one special reason for placing a test-point by the Inkaqonqorina block. In Arminda Gibaja's report on excavations and restoration work in Ollantaytambo, she briefly mentions that four wooden beams were found lying longitudinally underneath the block and that marks from three more could be seen (1982*a*:Ch. 6.05:Sector 7). I also had oral information that beams had come to light when the motor road was constructed. All the information I had agreed in stating that it had

Figure 54.
Part of a relief on the bottom surface of the Inkaqonqorina block. Test-point 9, block no. 41. The temple ramp. Facing S.

not been possible to move the block in modern times, so there was still a good chance that it lay *in situ*.

We re-opened Gibaja's trench, the trench we placed along a short side of the block. The aim was primarily to document Gibaja's observations. Underneath the block, there was still a cavity from the excavation made under Gibaja's supervision. The cavity reached 1.2–1.8 m inwards from the edge of the block. Further in, the ends of six tree trunks could be seen sticking out. The imprints from two more on the bottom surface of the block made a total of eight trunks (Figures 55, 56, and 57). Loose pieces of the trunks formed part of the trench infill. The imprints on the bottom surface of the block were dark in colour and quite distinct (Figure 57). The existence of the trunks must be considered a very valuable source of information for our understanding of how heavy building blocks were transported by the inkas.

The way the trunks are placed and their striking thinness are features that support the interpretation that they are vestiges of the original transportation of the Inkaqonqorina block towards the temple area. Taken together with other evidence, such as the weight of the block, the intact and compact soil under the trunks still in place and under the long side of the block, and the rectangular cross-section of the trunks, I feel confident in saying that the trunks represent a transportation device used by the inkas. We have here evidence that the inkas used trunks placed lengthwise under blocks for a bedding when moving blocks uphill. It should be added that there was no room to move the block at a right angle, so that the trunks served as rollers. The temple ramp is only 4.5–4.6 m wide, where measured, so it was only slightly wider than the block, which is up to 4.2 m wide. The statements that the inkas used rollers to transport blocks may have their basis in a cultural misconception. There was no tradition of using the wheel or similar inventions among the inkas. If the Europeans of today, or in the 16th century for that matter, were to place trunks underneath a large block to move it, they would most certainly place them transversely to make them serve as rollers. Therefore, it has been assumed by the Europeans that that was the way in which trunks were placed by the inkas as well. It is significant that, even when I had exposed the trunks under the Inkaqonqorina block and carefully described how they were placed and explained our findings to people with more than a basic education, then I would hear them remark that "Yes, the inkas used rollers". This was in spite of the fact that they could never have rolled. On the contrary, they had been placed like rails.

The trunks, as mentioned above, are strikingly thin. The intact ones measure only 5–10 cm in the horizontal plane and about 3 cm in the vertical. They have a rectangular cross-section, certainly due to the extraordinary weight that was placed on them. Judging from the imprints on the bottom surface of the Inkaqonqorina block, the trunks, after being

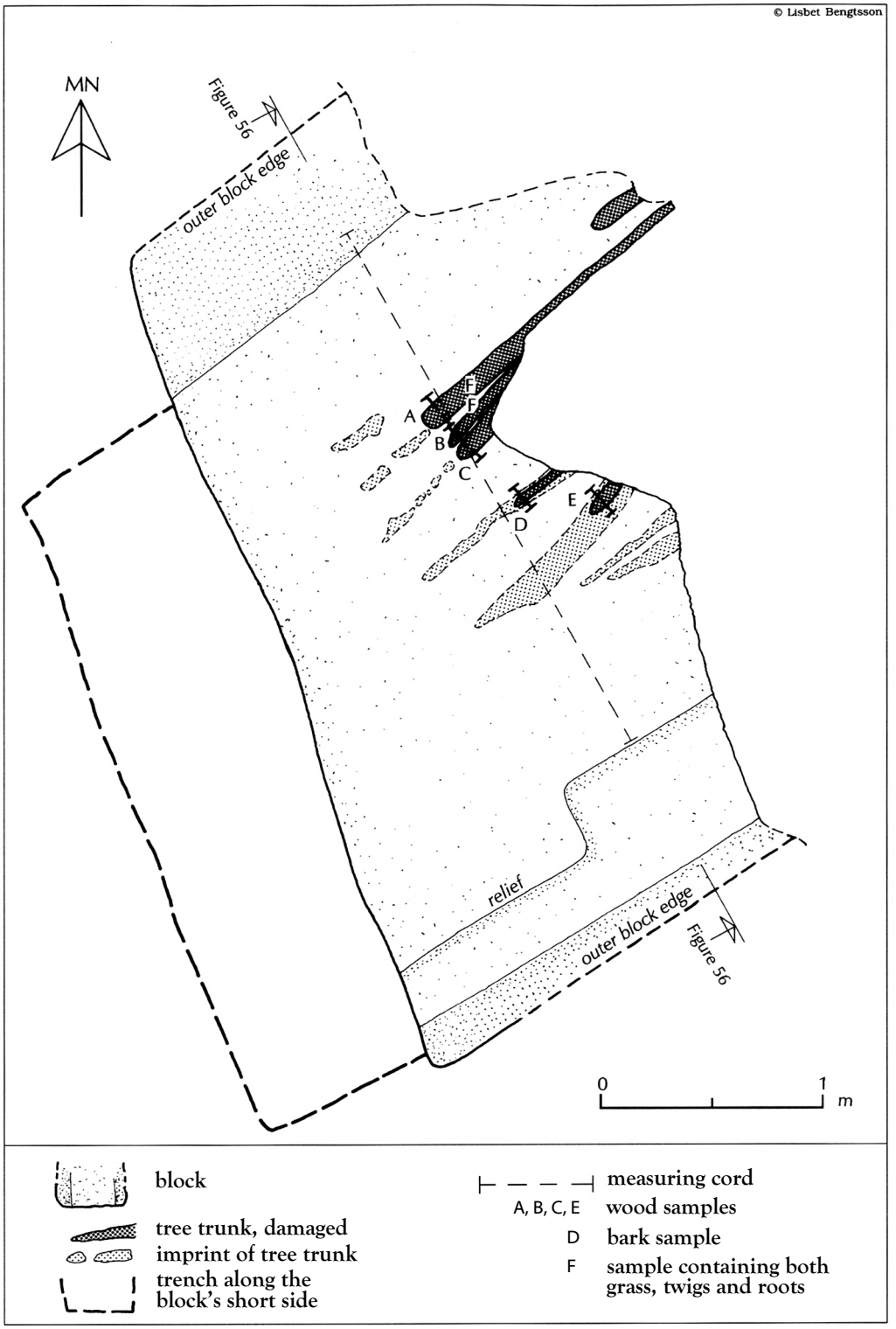
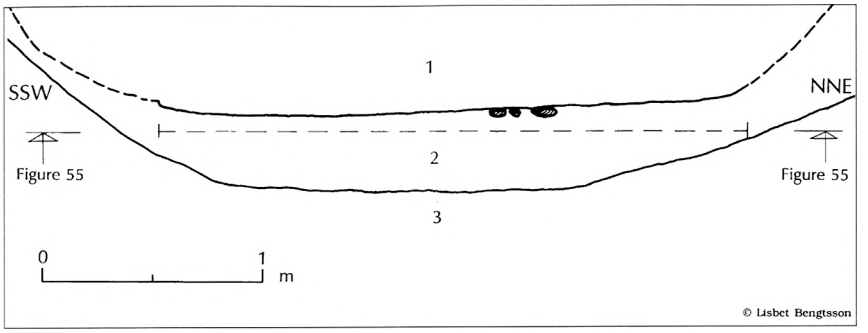


Figure 55.
Tree trunks and imprints of tree trunks underneath the Inkaqonqorina block as seen from below. Their presence means that trunks placed as rails were used as a transportation device. Test-point 9, block no. 41. The temple ramp.



1 block
tree trunk
measuring cord
2 space hollowed out in earlier excavation
3 brown to blackish-brown, compact soil with stones 0.01–0.20 m in diameter. The interior of the temple ramp

Figure 56.
Profile of the bottom surface of the Inkaqonqorina block as seen from the short side, with three of the tree trunks. The location of the cross-section is shown in Figure 55. Test-point 9, block no. 41. The temple ramp.

pressed down, had measured up to 14 cm in breadth. That indicates an original trunk diameter of less than 10 cm, a quite surprising piece of information. Why such thin trees were used, and why the trees were not barked is somewhat puzzling. Thicker trees do and certainly did grow in the valley, and to bark and plane the trunks would have further diminished the friction between the block and the subsurface. The trunks lie roughly parallel to each other but are not placed in regularly spaced rows. Instead, they lie 1–28 cm apart. Assuming that such major discrepancies are not due only to a sideways movement of the trunks during the trans-

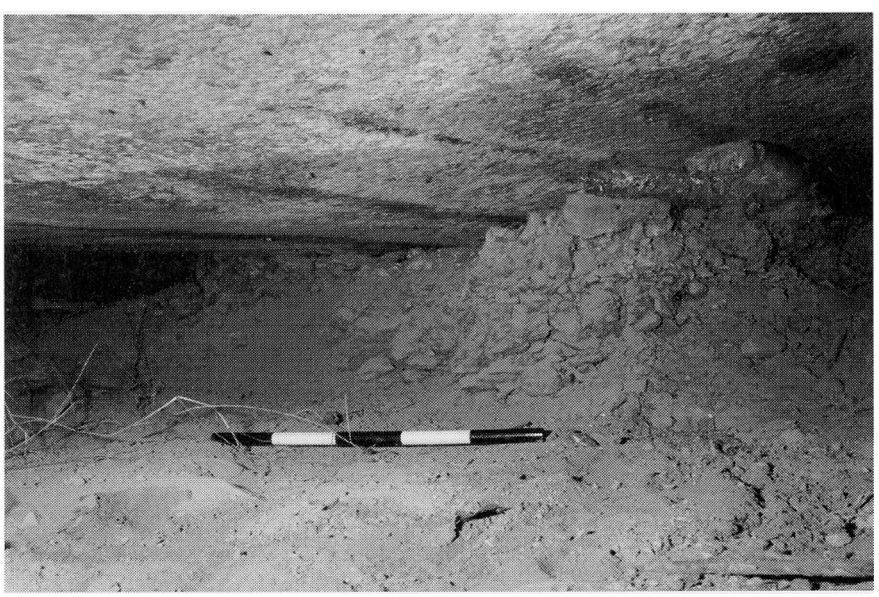


Figure 57.
Imprints of the tree trunks used as a transportation device are visible on the bottom surface of the Inkaqonqorina block. Remains of two of the trunks can be seen to the right in the picture. Test-point 9, block no. 41. The temple ramp. Facing SSW.

portation, my interpretation is that it was not a necessary element in the transportation to place the trunks at even intervals. It seems that no trunks were placed close to the edges of the block, since no trunks were to be seen there. This was probably because the shape of the Inkaqonqorina block is slightly convex, and the pressure of the block on the ground would therefore not have been as strong along its edges.

The bedding under the trunks consists of the temple-ramp surface and the ramp filling. The soil is dark brown and compact and contains stones 1–20 cm in diameter. The soil under the block along its south-western long side is similar in colour and composition and is tightly and evenly packed. The stones in the soil range from 1 to 13 cm in size. No disturbance from the road construction could be distinguished, and in this part the block, instead of lying on trunks, is lying directly on the temple-ramp surface.

There was a thin layer of about 2 cm of grass, thin twigs and thin roots between the trunks and, in one part, between the trunks and the block. The grass looked like *kikuyu* grass (*Pennisetum clandestinum*), which was introduced into the Vilcanota Valley after 1950 (Gade 1975:133). This, together with the fact that the twigs were not flattened by any weight on top of them, made me think that that layer was intrusive and had probably formed as a consequence of construction work on the motor road and that air had been given access to the underside of the block. The *kikuyu* spreads via rhizomes. Possibly the block had been slightly uplifted at the time, enough to form a small space between the block and the trunks. Also, the passing of heavy lorries just by the block makes the ground shiver and might have caused a minor uplift of it.

We took samples of five of the six visible trunks (Figure 55). One aim was to obtain a sample for radiocarbon dating. The result of the dating (of sample A) is presented in Table 4, lab. no. AA-2215, in section 3.1 on "Time span". Another aim was to try to have the species of the trees determined, so as to know whether they probably grew in the vicinity or whether they were brought from a distance, for example, from the *puna* highlands or from the mountain rainforest. Judging from the appearance of the wood and the bark, all the trunks were from the same kind of tree. For the three samples that were best preserved, that was also the case (letter from Professor Wheeler, October 8, 1987). The wood itself is greatly transformed and is more like tough, very dry and compacted sawdust than normal wood. The bark, on the other hand, is still well preserved (Figure 58).

The samples of wood were shown to the botanist César Vargas in Cusco, but he could not identify the wood by visual inspection. They were then sent to Professor Elisabeth Wheeler at the School of Forest Resources, North Carolina State University at Raleigh, U.S.A. She made various attempts to identify the wood by comparing it with the in-

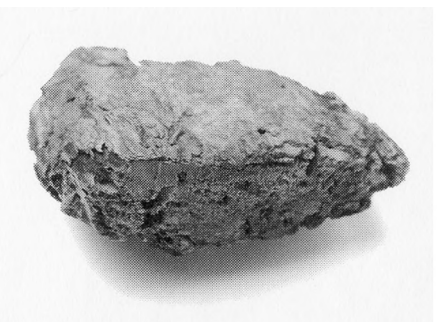


Figure 58.
Wooden sample (sample A) from one of the trunks under the Inkaqonqorina block. A small piece of the sample was radiocarbon-dated. Test-point 9, block no. 41. The temple ramp.

formation in a computerized database covering over 5,000 woods from different parts of the world, but the results were negative. However, the search had some value, since four trees could be discarded from the list of candidates. Gibaja says in her report that the trees used for the Inkaqonqorina block were *lambrán* and *sauco* (1982*a*:Ch. 6.05:Sector 7). *Lambrán (Alnus jorullensis*, in Quechua *ramram*), a native alder tree (Gade 1975:152), could be excluded as a possibility. *Chachacoma* (*Escallonia resinosa)* has been put forward locally as one alternative. It is a native tree that grows in the mountains surrounding Ollantaytambo, but the samples are not from that tree. The third alternative that was discarded was the *kishwar* (*Buddleia* spp.), a native poplar that grows in the valley and in the mountains surrounding Ollantaytambo. The fourth suggestion discarded was *qeuña (Polylepis* spp.). Among the suggestions, still unproven, are the *sauco* (*Sambucus peruviana*) mentioned above and suggested by Gibaja and also by Astete (1952:226); *lloke (Kageneckia lanceolata*); and the stem of the *chuchau*. The *sauco* is a rather small, elder tree common in hedgerows in the valley, between 2,800 m and 2,500 m a.s.l. (Gade 1975:88, 216). The *lloke* is a shrub or small tree with flexible but strong wood. It is rare today but can be found at above 2,700 m a.s.l. in the valley. One use the inkas made of it was for the construction of bridges (Gade 1975:162–163; Yacovleff & Herrera 1935:37–38). The *chuchau* probably corresponds to *Furcraea andina* (González 1989:118 [1608]; Gade 1975:147). Its stem is not a very hard wood but is very durable. There are roof beams of *chuchau*, still intact, in buildings from colonial times. *Chuchau* grows in the valley and on the mountain slopes close to the valley floor.

The pressure exerted on the tree trunks under the Inkaqonqorina block could probably be supported by various kinds of trees. For the purpose of calculation, we can assume that there were originally eight trunks with a mean breadth of 10 cm that extended along the whole length of the block. We can also assume that my estimate of the block's weight (70 tons) is correct. The weight on each square centimetre of wood would then be 1.4 kg.

The trunks diminished the friction with the ground considerably. If the wood was fresh, its sap helped to diminish the friction even more. The weight of a stone placed and dragged on wood diminishes to about one-fifth. Accordingly, 100 kg of stone dragged on wood corresponds to only 20 kg of weight. If this calculation is valid for the Inkaqonqorina block and if we assume that each worker moved 100 kg of stone corresponding to the weight of 20 kg, then 700 workers were needed to move the block, if it weighed 70 tons. The workers might have been capable of moving more than 100 kg each, but we also have to take into account the extra resistance due to the ascent. How such an immense work force

was organized and how the combined strength of all the workers could be concentrated on a single block on a narrow ramp is a problem still unsolved.

[1] 0^g is along the horizontal line, and 100^g is along the vertical. ^{g} means *gon* and is used for the "new degrees", with 400^g completing a circle (rather than the traditional 360°).

[2] The weight is calculated on the following measurements of the block: length 5.6–6.0 m×breadth 2.8–4.2 m×height 0.8–1.46 m×density 2.7.

2.5 Fine preparation

Fine preparation was the stage in the labour process when the blocks were given the final touch. The process included adjusting the sizes and shapes of the blocks, making the surfaces more even and preparing the edges.

There are a few blocks that show that fine preparation sometimes took place already in the rock-slide areas. One example is a large block which has an evenly prepared and slightly convex bottom surface (Figure 59). Such bulging surfaces are typical of façades, and it is very likely that the block was to be set into a wall so that the bottom surface formed the face. On another block (no. 107 in the southern rock-slide area), the preparation marks indicate that the workers intended to give a convex shape to the upper surface, but the process was only started.

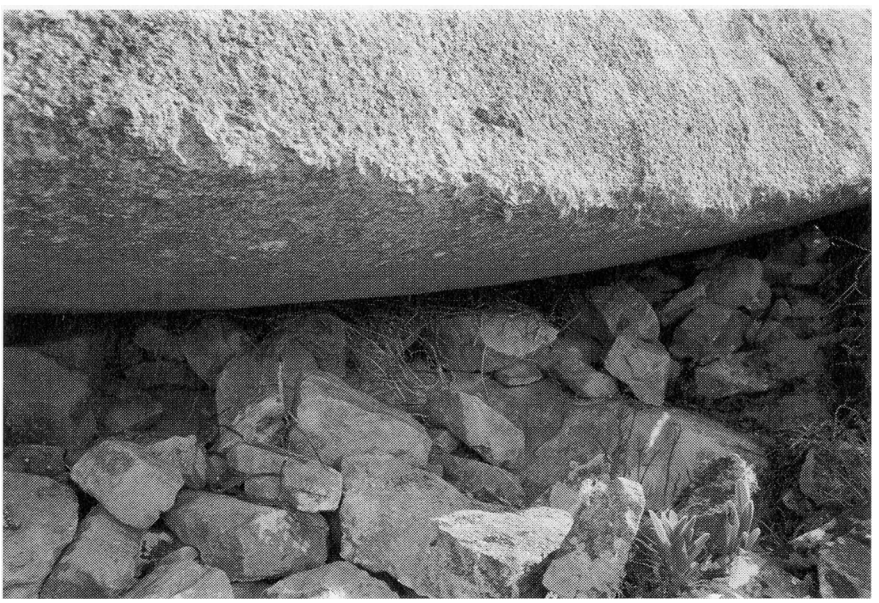


Figure 59.
Fine preparation occasionally took place already in the rock-slide area. Finely prepared and convex bottom surface of a block. Block no. 106, the southern rock-slide area. Facing SW.

Other examples are two reliefs on blocks which had not yet been moved out of the rock-slide areas. One is a square, high relief on an upper surface (Figure 60). The high relief, although unfinished, is similar in appearance to the relief on the upper surface of block no. 40, discussed in section 2.2 on "Splitting". We should thus reckon with the possibility that it was really meant to remain as a relief and that the upper surface was to become part of a façade. The other relief is a rectangular, low relief placed in an asymmetrical way on a block's surface. On comparing it with blocks in the temple area, I found no low reliefs placed in such a

way on a block. Possibly the low relief on the block in the rock-slide area would have been obliterated at a later stage in the preparation.

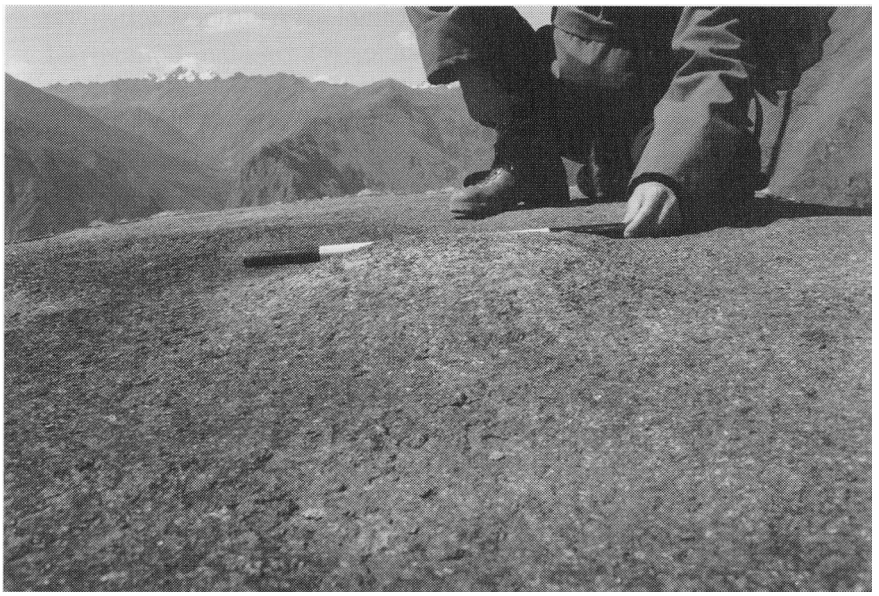


Figure 60.
A square, high relief begun on a block which was not yet moved out of the rock-slide area. The southern rock-slide area, block no. 103. Facing E.

If we turn to the transportation route, there is no conclusive evidence that fine preparation took place along it. There are blocks that show traces of fine preparation, which will be commented on below, but it may be that the work was carried out before the blocks were moved out of the rock-slide areas. The trenches that we opened up along the route contained no flakes or stone dust. In section 2.4 on "Transportation", I mentioned that there are flakes on the surface below the long chute down to the valley floor, but the flakes had probably been placed in the chute to diminish the friction with the ground and had accumulated below the chute when moving blocks down it and because of later erosion. The other point in the terrain with indications in the ground of preparation having taken place outside the rock-slide areas is the storage space for blocks at Nawinpata on the Kachiqhata slope, mentioned in section 2.3 on "Rough preparation". It is not certain, though, that any fine preparation took place there.

Most of the fine preparation took place at the building site, that is, the temple area. There are few blocks in other sectors of the investigation area which have finished sides. On the other hand, and seemingly in contradiction to this, there are a number of blocks lying along the transportation route with striation marks, which may have arisen from honing. A few of them are discussed in section 2.4 on "Transportation". They may have striations on one or more sides or edges, but, in spite of this,

the preparation by flaking and pounding was not necessarily completed. As blocks placed in walls in the temple area do not have striations, except along their edges, my conclusion is that any honing done before a block arrived at the temple area was not final. The ultimate touch was given once a block had reached the temple area.

A type of installation peculiar to the temple area is a very narrow platform that was built of stone and mud and on which a block was placed (Figures 61 and 5*b*). One reason for building them was probably to form level ground for a block that was to be finely prepared. Another reason might have been to facilitate the subsequent handling of the blocks. Today, they are restored. As far as can be judged from old photographs, they were built too narrow to be useful as scaffolds.

The fine preparation should have left evidence in the ground, such as flakes and stone dust. Unfortunately for us, the open space in front of the temple has undergone some changes in the present century. A few of the prepared blocks have been moved, and the ground has been cleared of stone litter, a litter which probably consisted in part of natural stones, in part of flakes, and possibly in part of hammerstones. The ground level by the front temple wall has changed over time, as can be deduced from old photographs (1893–1895:3:516; photographs on glass plates taken by Martín Chambi, probably in the 1920's and the early 1930's). In addition to the ground level that existed at the time when the photographs were taken, a former ground level can be deduced from the differential growth of lichens on the façade. The façade has since been cleaned, and today no such difference can be distinguished. We do not know to what extent the higher ground level was the result of soil accumulation over the centuries following the construction or to what extent it may have represented the ground level when the temple was built. At least some of the soil formerly covering the lowest part of the wall was most probably deposited in the form of airborne particles, as the front of the temple faces to the leeward, away from the strong winds that sweep up the Vilcanota Valley.

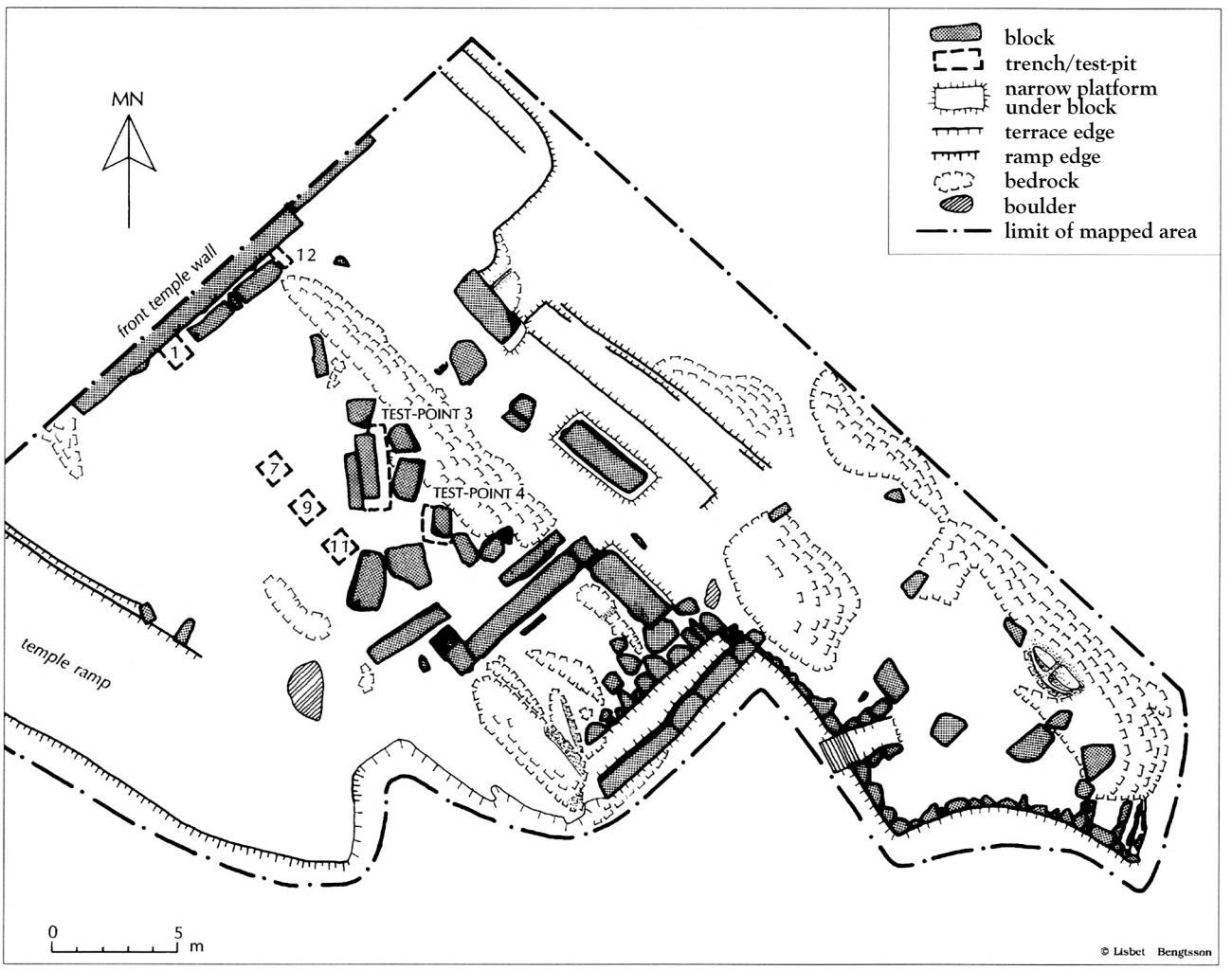
Although the published material on the cleaning, excavations and reconstructions in Ollantaytambo in the early 1930's is quite extensive (Llanos 1936; Valcárcel 1934*a*:184), we still lack any precise information on what was done in the temple area at the time. The ground level, at least on the sides of the temple, was quite certainly lowered during that work, as can be discerned in photographs taken in the second half of the 1930's (Doering 1941:242–243). Later in the present century, the ground was hardened and made more resistant to compaction by tourist activity. A layer including clay and lime was spread out over the surface, and above it a thin layer of water-rolled pebbles was placed. That layer was covered with soil (Arminda Gibaja de Valencia, personal communication, Cusco, 1985).

Even though the space in front of the temple had been cleaned and the ground levelled, we hoped to recover evidence relating to the stonework, and we opened up some trenches and squares there. The excavations were divided into test-points 3, 4, and 8.

Test-point 3 included a trench placed by a prepared block of Allinyana material lying partially embedded in the ground (Figures 61 and 62). As the block lay close to exposed bedrock and somewhat to the side of the free space, we considered that the possibilities of finding the ground undisturbed by later activities were comparatively favourable.

The soil contained a culture layer, although it was disturbed in the southernmost part of the trench. The layer included stone dust, which formed clods down to a depth of 3 cm below the block's bottom surface. A grain-fraction analysis and a hydrometer analysis were made of the

Figure 61.
The inner temple area. The sides and back of the temple are not included in the plan. Test-points 3 and 4 are marked, as well as the test-pits numbered 1, 7, 9, 11, and 12, which together form test-point 8. The south-eastern corner of the plan is at a lower topographical level and includes part of the outer temple area.



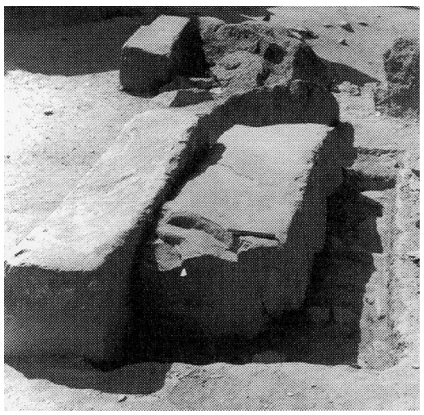


Figure 62.
Trench at test-point 3 after excavation. The temple area. Facing N.

dust and compared with a sample from the block's lower edge, and the results showed that the samples corresponded to each other and to samples from the rock-slide areas. We can therefore now say with certainty that blocks of Allinyana material were finely prepared in the actual temple area. This is in contrast to the idea put forward by Lee Hollowell, that the final preparation of the blocks was done elsewhere (personal communication, Ollantaytambo, 1985). If we assume that the stone dust came from the block that lies there now, then the current stage of preparation was that of hammering the surface. The block shows no striation marks but only marks from flaking and pounding.

At test-point 4, another trench was excavated by a prepared block. The block is not of Allinyana material but was chosen because it has striation marks all over its upper surface and lies somewhat in the ground. A primary aim was to search for evidence of the honing procedure. Unfortunately, we did not have time to excavate to a level below the bottom surface of the block. Some cultural material was recovered, but, as far down as we reached, there were no indications of a layer of flakes and stone dust there.

Test-point 8 included five test-pits, numbered 1, 7, 9, 11 and 12 (Figure 61). Under the layers of pebbles, clay and lime, there was a culture layer in all the pits, except in square no. 1, which was by the temple wall. The culture layer was thicker further away from the temple wall than closer to it, most probably due to soil creep. In the culture layer, there were a few prepared stones, which lay in disorder. They looked more like paving stones than stones to be placed in a wall. Maybe they were to be used elsewhere, but we should reckon with the possibility that the open space in front of the temple was once partly paved. Although it was not an aim of this thesis to study the actual construction of the temple, it is worth mentioning here that in the two test-pits we opened by the front temple wall, it became clear that the wall lacks a foundation and that the blocks were set directly on or into the ground.

The culture layer at test-point 8 contained no distinguishable stone dust. There were a few pieces of rock of Allinyana material, most likely flakes, though they lacked sufficient characteristics to enable them to be determined as such. If the whole space in front of the temple once had a layer of flakes and stone dust in the ground, it must have formed part of the uppermost level of the culture layer only; otherwise, it must have been distinguishable in our test-pits.

There was a soil layer between the culture layer and the bedrock below. That soil had not been naturally formed on the spur. Instead, it had been water-transported and thus brought from elsewhere. A sample of the soil was submitted to sieving analysis, grain-fraction analysis, and microscopical analysis. It was shown that the grains were well rounded and had a spherical shape, indicating that the soil had been transported by

water a fairly long distance (Inger Liebig, Department of Geology, Göteborg University/Chalmers University of Technology). Evidently, a major effort had once been made to form a convenient, flat space on the mountain spur. Presumably, this was done when the temple was to be built there. To prepare the ground, soil was brought in, and I would suggest that the source was a calm section of the Vilcanota river-bed about a kilometre away.

Preparation techniques

The workers struck flakes from the blocks and pounded the surfaces in the same way as for the rough preparation, although they took more care in shaping the blocks and in general used less force and, as it seems, smaller tools. Sometimes they seem to have started a honing procedure before the blocks were given their final shapes, but the most common procedure was to hone only the edges that needed precise fitting.

The tools normally used for the flaking and pounding were in all probability hammerstones. The grounds for this statement are that the pit marks formed by each blow on the surfaces of finely prepared blocks are similar to the pit marks on roughly prepared blocks (Figure 63), that they have a shape and size that correspond to tools with a rounded, blunt edge like small hammerstones, and that the only tools found so far related to the stonework at Ollantaytambo are in fact hammerstones.

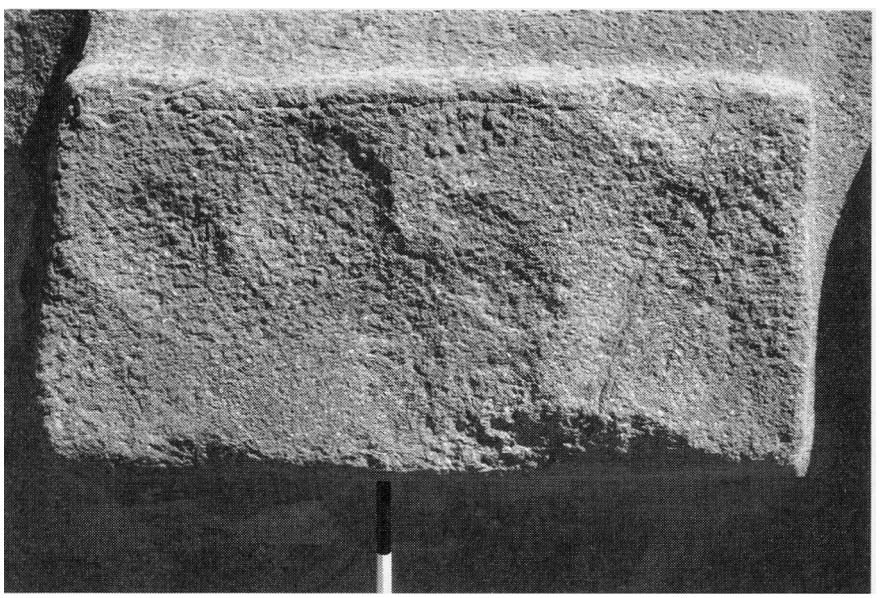


Figure 63.
The pit marks made by crushing the surfaces during the fine preparation give the surface a slightly coarse texture. On a relief on a side wall of the temple. Facing SW.

The vestiges of the honing procedure show as striations and can sometimes be distinguished as scratches (Figure 64). Some edges were

Figure 64.
The edges of blocks were honed. On this block, the scratches along the edge can be distinguished. The temple area. Facing SE.

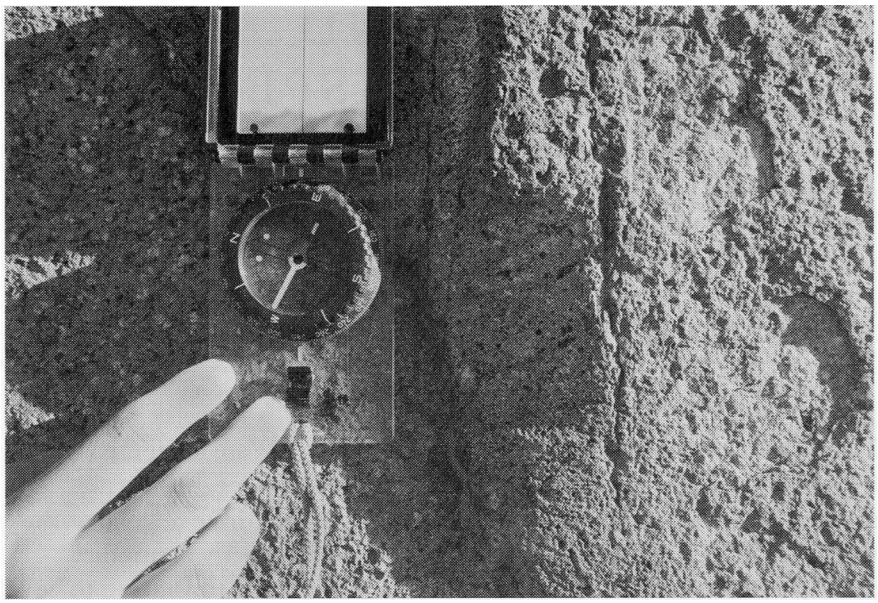
honed so carefully that the surface became glossy, and the honing marks can be distinguished only with difficulty. In most instances the movement was straight and alongside the edge, hut occasionally the movement was perpendicular to the edge (Figure 65). I have found no examples of a circular movement.

It has been said that the honing was done by rubbing with wet sand and by using stones or wood with water and sand or some other agent, such as hide or wool, for the glossy parts (see Agurto 1987:131; Gonzales 1971:64–65; Kauffmann 1983:653). We found neither a layer of sand in our test-pits in the temple area, nor any wood, hide or wool, so I cannot confirm any of these statements.

Figure 65.
Edge honed perpendicular to the edge. The temple area.

In addition to the presumed hammerstones and the abrasive agent or agents for the honing, at least one instrument was used for the fine preparation. It was a tool with a sharp edge. It was used for the reliefs with a stepped motif on the front temple wall. The edge was apparently straight and had a width of about 7 cm, as far as can be estimated from the width of, and the striations in, the lowermost "step" of one of the signs (Figure 66).

It seems that, in addition, some other kind of tool was used. For a few of the other details on the blocks in the temple area, neither hammerstones nor tools with a straight and broad edge would have been effective. Examples are the T-shaped sockets (Figure 65), the narrowest of which are only the width of a finger, in which no hammerstone would fit.



(*b*)

(*a*)

Figure 66 *a-b*.
A tool with a sharp edge was used for some details.
(*a*) Three stepped signs on the front temple wall. Facing NW.
(*b*) Detail of the lowermost sign. The width of the tool edge can be estimated as about 7 cm. Facing NW.

3 SOCIETAL AND CULTURAL ASPECTS

3.1 Time span

Many constructions at Ollantaytambo and their uses are attributed to the inkas. This is the information given to us in the ancient, historical sources. These sources are not consistent as to which Inka reigned at the time, and in one source the information seems to directly contradict other particulars on the inkas. This source is Betanzos, considered to be one of the most reliable writers on the inkas, who says that the valley of Yucay was uninhabited when Wayna Qhapaq visited it (Table 3). If the valley of Yucay was uninhabited, it seems logical to conclude that Ollantaytambo was also, because Ollantaytambo is further away from Cusco than the valley of Yucay proper (see footnote in section 3.3 on "Groups in Ollantaytambo possibly involved in the stonework"). Wayna Qhapaq reigned late in inka times (Table 1). It could be expected that as fertile a valley as the valley of Yucay, so apt for maize cultivation and so close to Cusco, would have been exploited long before Wayna Qhapaq's reign. The datum given by Betanzos is included in the table below (Table 3), although he makes no specific mention of Ollantaytambo.

Single buildings at Ollantaytambo cannot be identified with any certainty in the sources in Table 3. The construction of the so-called Sun Temple, which is of special interest in this study, is not mentioned as such. The sumptuous buildings may include the Sun Temple, but those buildings are in any case attributed to two different Inkas.

Later sources have added other construction periods to those mentioned in the early sources. Considering the amount of construction work at Ollantaytambo, Angles argued that the Inkas did not reign long enough to get it all built and suggested that the remains considered to have been built during the inka empire are more ancient (Angles 1978:5). Also Luis Pardo believed the Sun Temple and other constructions at Ollantaytambo were from a period prior to the Inkas, and he related them to the remains at Tiwanaku, which is in the Lake Titikaka region (1946). Louis Baudin similarly placed Ollantaytambo within the "Tiwanaku empire" (1978:97–98). By modern standards, that would date

Table 3.
Constructions built or used in Ollantaytambo and close by, according to ancient sources, and the Inka rulers mentioned in those connections. The rulers are placed in chronological order, the most recent at the top.

Ruler	Place	Constructions built or used	Source
Mango Ynga	Tanbo (identified as Ollantaytambo)	Built a fortress	Titu Cusi Yupanqui (1992:46–49 [1570:39–42v.])
Guayna Capac	Valley of Yucay	The valley was uninhabited. Wayna Qhapaq entered it with 150,000 people, flattened the valley floor, canalized the river, had houses built for the Inka and for the lords of Cusco, both living and dead. Had villages built and *mitmaqkuna* placed in them	Betanzos (1987:186–187 [1551 :Chs. 42–43])
Tupa Inca Yupanqui	Tambo (could be either Ollantaytambo or Paqariq-tambo)	The palaces were built	Cobo (1991:149 [1653:Bk. 12, Ch. 15])
Pachacuti	Tambo (most probably Ollantaytambo)	Finished the buildings	Sarmiento (1988:114 [1572:Ch. 41])
Inca Pachacuti	Tambo (identified as Ollantaytambo)	Made some very sumptuous buildings	Sarmiento (1988:112 [1572:Ch. 40])
Pachacutiynga Yupangui	Tambo (identified as Ollantaytambo)	Had house(s), lands and other properties	Archival document from 1585, in Rostworowski (1970:159)[a]
Inga Yupanqui (corresponds to Pachakuti Inka Yupanki)	Tambo (identified as Ollantaytambo)	Built Tambo	Archival document from 1567, in Villanueva (1970*b*:160)[b]
Inca Viracocha	Valley of Yúcay buildings made down, in Tampu (identified as Ollantaytambo)	Had large and sumptuous buildings made	Garcilaso (*c.* 1980:2:108 [1609:Bk. 5, Ch. 27])

[a] Originally from Archivo Histórico del Cuzco. Libro 3, índice 5, foja 884 r., año 1585, "Genealogía de la casa y descendencia de don Diego Saritupac Manco Ynga Yupanqui". Rostworowski (1970) has used a version which is in the Archivo General de Indias, Escribanía de Cámara 506 A. That document summarizes the whole case.

[b] Originally from Archivo Histórico del Cuzco. Libro 4, ff. 17–115, "Genealogía de la Casa, Ascendencia y Descendencia de don Diego Sairitúpac". This belongs to the set of documents of which a summarized version exists, referred to by María Rostworowski (1970) under a slightly different name.

the construction of the Sun Temple in the first millennium after Christ. Indeed, some features, such as the staircase sign on the front temple wall and the sockets in blocks apparently made for clamps to couple them, are reminiscent of Tiwanaku features.

Victor von Hagen, on the other hand, writes that the fortress of Ollantaytambo was being built when the Spaniards arrived in Ollantaytambo in A.D. 1536 and that construction at Ollantaytambo took place even after that (1961:137, 192–193). From his writing, it can be inferred that he means that the stonework concerned here was interrupted by the arrival of the Spaniards. The same view is expressed by Arminda Gibaja (1982*a*:Ch. 6.06:Conclusiones, 1984:238). Ann Kendall writes that additional fortifications and a palace were built in A.D. 1536–1539, when Manko Inka was in Ollantaytambo (1974*b*:2:289, 1976*a*:81).

In the excavations carried out in different sectors of Ollantaytambo by personnel at the Instituto Nacional de Cultura in 1980–1982, over 59,000 ceramic fragments were recovered and analysed. About 0.5% were Killke (Late Intermediate Period), 60% were inka, 32% were colonial, and 7% were more modern (Gibaja 1982*a*:Ch. 6.06). Other sherds, including ceramics from the Early and Middle Horizons, comprised 0.5% of the total amount. Gibaja does not specify the contexts of the different types of ceramics, but it is clear from her report that inka sherds greatly predominated in the excavated sectors and that the presence of ceramics from earlier occupations was minimal. The Killke ceramics are considered to represent the early inka state, before its expansion from the Cusco region (Rowe 1944:61). The inka ceramics are considered by most scholars to roughly represent the time of expansion. With this view and judging from the results of the excavations in 1980–1982, most, if not all, of the buildings which formed part of the investigated sectors were erected only in the last few generations of the inka state, once its transformation into an empire had begun. To my knowledge, no precise date for the beginning of the production of inka ceramics has yet been established, and no manufacturing site or kiln for the inka ceramics produced in Cusco has been recognized (see Heffernan 1989:1:104, 110).

Nine radiocarbon datings from *buildings*, which were assumed to be from inka times, have been reported from the Ollantaytambo district by Bauer (1992:44; also see Hollowell 1987:132; Kendall 1974*b*:2:374, 377). Three of them are from buildings close to the temple area, one of them is from a building on the Kachiqhata slope, and one is from the Intipunku remains on the Intihuatana spur north-west of Kachiqhata. With the calibrations presented by Bauer, these five samples cover a time span from about A.D. 1280 to about A.D. 1650. That corresponds to the Late Intermediate Period through the Late Horizon and into the Colonial Period. The remaining four datings were from Pumamarca, a site some

kilometres north-east of Ollantaytambo itself. Since Bauer wrote, four more datings have been presented for Pumamarka (Kendall 1995:46). None of these buildings were of fine masonry.

As mentioned in section 1.2 on "Previous research and present state of knowledge", Bauer reports only three radiocarbon dates from clear Killke contexts and only one associated with inka ceramics from *excavations* in the Cusco region (1992:45–46). To these can be added the two dates from Machu Picchu and the one from Qata Casallacta mentioned in section 1.2. None of these is from the Ollantaytambo district. There are also the few datings of skeletal material from Machu Picchu, as well as the dating of a human bone collected in a grave-house in the Llaqtallaqtayoq sector north-west of the Kachiqhata quarries (Kendall 1995:46).

To try and date the stonework at Ollantaytambo, we had organic material age-determined. We also had ceramics analysed, and we made observations on the relative ages of some features.

Radiocarbon measurements

Altogether, we submitted thirteen samples from our investigation area for radiocarbon dating (Table 4). For all samples, a tandem accelerator mass spectrometer was used. A correction corresponding to $\partial^{13}C = -25$ per mil against PDB was made. The calibration program used was that of the University of Washington Quaternary Isotope Laboratory (Stuiver & Reimer 1993). The version is the Radiocarbon Calibration Program REV 3.0.3, in which the Dataset 1 calibration file (a bidecadal tree-ring dataset) was used (INTCAL93.14C). All B.P. values have been reduced by 40 years before being entered in Table 4, to correct for the Southern Hemisphere provenance of the samples.

The samples

Three of the organic samples were taken from underneath blocks in transport, one was taken from the temple-ramp construction, and three from the temple area. The aim was to date the transportation and the use of the temple area. The remaining six samples were extracted from grave-houses (see below).

Test-point 2, block no. 48 in Rumira field, the valley floor (*AA-1528*)
The sample was collected by scraping out 1 kg of soil to a depth of 0–4 cm under the block, well inwards from the block's south-western corner (see Figure 48). The organic material was separated by flotation in water saturated with salt.

Test-point 9, *1Ma*, *block no. 41*, *low on the temple ramp (AA-2215)*
The sample to be dated was extracted from a wooden sample of one of the thin tree trunks used as a transportation device for the block called Inkaqonqorina, which lies low on the temple ramp (Figures 38 and 53). The wooden sample is the one labelled A in Figure 55, also shown in Figure 58. The sample to be dated was extracted from the outermost part of the trunk, inside the bark.

Test-point 9, 6M*a*, *block no. 41*, *low on the temple ramp (AA-2216)*
The layer of grass, thin twigs and thin roots under the Inkaqonqorina block, that is, between the block and the tree trunks used as a transportation device, was dated. The sample contained a level of ^{14}C greater than "modern" (A.D. 1950). The level is consistent with either the late 1950's or the early 1970's. The sample is not included in Table 4.

The temple ramp (AA-*2217)*
Ichu grass used for a binding was extracted from the mortar of the innermost of the three layers of the temple-ramp wall, by the collapsed segment shown in Figure 43.

Test-point 3, *the temple area (AA-1529)*
Charcoal was collected close to the south-eastern corner of the block, by which a trench was excavated (Figures 61 and 62). The sample was taken at the bottom level of the block. It gave a post-bomb date corresponding to the 1950's. It is not included in Table 4.

Test-point 8, *test-pit no. 1*, *the temple area (AA-1530)*
Test-pit no. 1 was excavated right by the front temple wall (Figures 61 and 67). The charcoal sample was collected 7 cm away from the wall and 1.5 cm above its base.

Test-point 8, *test-pit no. 11*, *the temple area (AA-1527)*
Charcoal was collected from the south-eastern profile of test-pit 11 (see Figure 61), from the bottom of the culture layer. The sample corresponded to a time span from the 1890's to the 1950's. It is not included in Table 4.

Figure 67.
Test-point 8, test-pit no. 1, the temple area. One of the samples for radiocarbon dating was collected close to the front temple wall. Facing NW.

Grave-houses *(ch'ullpas)* on the Kachiqhata slope were also dated, because they have been considered by some to be related to the stonework. They would be the last resting places of stoneworkers, some of whom may have died in accidents while executing their tasks (Pardo 1946:54–55). Indeed, some of the grave-houses stand close to vestiges of stonework (Figure 68), and some have their openings towards the mountainside, where the rock-slides are and much of the stonework took place, and not towards the valley, as might otherwise be expected. Four grave-houses were dated. Three of them stand near evidence of stonework. There is such evidence within a few metres of *ch'ullpas* nos. 33 and 2, and

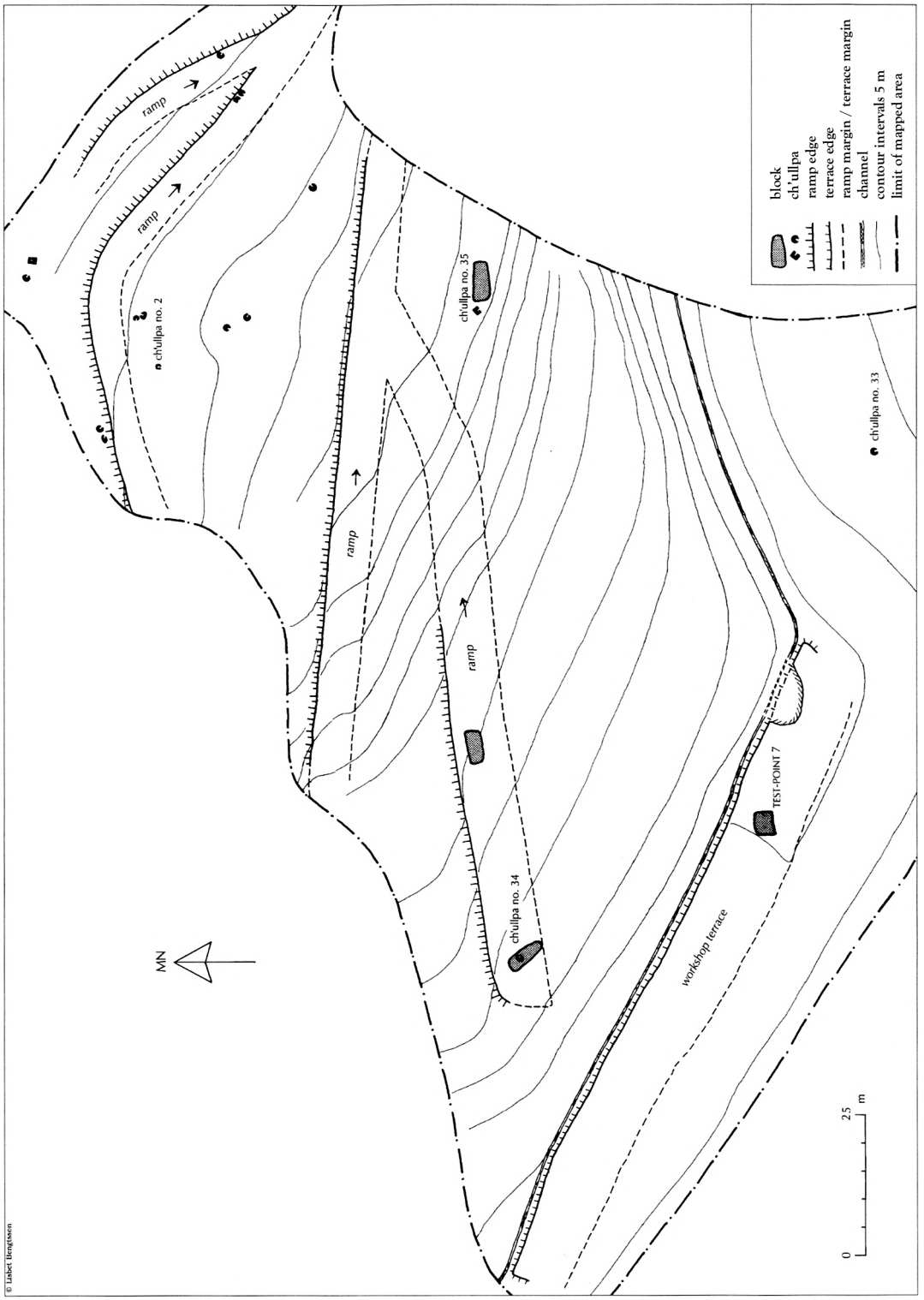


Figure 68.
Grave-houses (*ch'ullpas*) in the northern rock-slide area stand close to vestiges of the stonework.

ch'ullpa no. 35 stands only 1.3 m from a large block (Figure 69). A collapsed *ch'ullpa*, no. 34, even stands on top of a large block (Figures 68 and 70). Unfortunately, the mortar used for *ch'ullpa no.* 34 contained too little organic material to be dated. *Ch'ullpa* B stands outside the rock-slide areas and was dated for comparison with the grave-houses that stand close to the vestiges of stonework.

Figure 69.
Ch'ullpa no. 35 stands only 1.3 m from a large block. The northern rock-slide area. Roughly facing NE.

Ch'ullpa no. 35, *Kachiqhata (Ua-1711)*
The grave-house is in the upper part of a sector called Mollepuqro, in the northern rock-slide area. It has its opening turned towards the mountainside. The sample was extracted from the plaster of the wall on the outside of the grave-house. The sample was sieved in water, and the *ichu* grass from the plaster was submitted for dating.

Ch'ullpa no. 33, *Kachiqhata (Ua-1710)*
The grave-house is located above a sector named Mandorpuqio. It stands above and to the south-east of the work terrace of the northern rock-slide area, where test-point 7 was located. Its opening is towards the mountainside. The sample was extracted from a beam used as a support in the ceiling of the chamber. It was taken from the outer part of the trunk, after removing the bark and after scraping the exposed surface. The beam was a *chachacoma* (*Escallonia resinosa*) trunk, according to Leoncio Monteagudo (personal communication, Ollantaytambo, 1989).

Ch'ullpa no. 2, *Kachiqhata (AA-1407B, Ua-1709)*
The grave-house is in the sector called Mollepuqro, in the northern rock-slide area (Figure 68). Two samples were extracted, and they were

from the plaster of the same wall inside the grave-house. They were collected on different occasions and submitted to different laboratories. The grave-house is narrow, compared with other grave-houses on the Kachiqhata slope. Its opening is towards the mountainside. *Ichu* grass had been used as a binding material in the plaster.

Ch'ullpa B, Kachiqhata (AA-2218)
Ch'ullpa B is a grave-house that was built to the north-west of all three rock-slide areas, in a sector called Llaqtallaqtayuq. Near the grave-house is a wall reminiscent of Middle Horizon architecture. The sample was extracted from the plaster on the outside wall, and the *ichu* grass used for a binding material in the plaster was dated.

Figure 70.
Ch'ullpa no. 34 stands on top of a large block. The collapsed grave-house is in the centre left of the picture. The northern rock-slide area. Facing WNW.

Results

The results from our investigation area support the well-established view that the fine masonry was built under inka rule and not earlier. Unfortunately for any archaeological research on inka society, the 16th century is a period with a rather constant ^{14}C content, and we did not obtain one narrow range upon calibration. However, one or more ranges can be excluded from the possible construction periods, as no fine masonry was constructed after the 1530's. There are some buildings which were remodelled or constructed in the early years after the Spanish conquest and which are similar to the fine masonry, but they can be distinguished from the fine masonry by certain features alien to the native tradition (Gibaja 1982*b*; Harth-terré 1958; Hyslop 1990:26; Kauffmann 1983:654:Figure 6; Kubler 1952).

Table 4.
^{14}C dates calibrated according to Stuiver & Reimer (1993). The samples are placed in chronological order, with the most recent at the top. The grave-houses (*ch'ullpas*) are placed separately.

Site	Sample material, context	Lab. no.	B.P.	Cal. AD, 1 sigma, possible range/ranges	Cal. AD, 2 sigma, possible range/ranges
Test-point 8, test-pit no. 1, the temple area	Charcoal	AA-1530	280 ± 60	1520–1569, 1627–1666, 1951–1952	1471–1683, 1744–1807, 1933–1954
Test-point 2, under block no. 48 in Rumira field, valley floor	Undefined organic material	AA-1528	280 ± 70	1516–1591, 1621–1669, 1786–1793, 1948–1953	1452–1689, 1732–1813, 1925–1954
Temple ramp	Ichu grass, from wall	AA-2217	369 ± 66	1447–1640	1429–1661
Test-point 9, 1 Ma, under block no. 41 low on temple ramp	Tree trunk, under Inkaqonqorina block	AA-2215	416 ± 49	1439–1490, 1606–1612	1422–1635
Ch'ullpa B, Kachiqhata	Ichu grass, from wall	AA-2218	414 ±49	1440–1496, 1604–1613	1423–1636
Ch'ullpa no. 35, Kachiqhata	Ichu grass, from wall	Ua-1711	445 ± 60	1428–1481	1403–1527, 1553–1633
Ch'ullpa no. 33, Kachiqhata	Tree trunk, from ceiling	Ua-1710	445 ±60	1428–1481	1403–1527, 1553–1633
Ch'ullpa no. 2, Kachiqhata	Ichu grass, from wall	Ua-1709	660 ± 65	1287–1397	1260–1416
Ch'ullpa no. 2, Kachiqhata	Ichu grass, from wall (contaminated with charcoal?)	AA-1407B	1110 ±60	885–1005	785–1026

With this in mind, and using the one-sigma ranges, it may be concluded that blocks were transported on the valley floor and low on the temple ramp *c.* A.D. 1440–1530's. The construction of the temple ramp took place *c.* A.D. 1450–1530's (Figure 71), and one period of use or construction in the temple area was *c.* 1520–1530's. The age of the tree trunk used to move the Inkaqonqorina block is certainly interesting. The narrow range of the one-sigma standard deviation that remains—if we disregard the range that covers a time span after the arrival of the Spaniards—is *c.* A.D. 1440–1490. For stonework to produce the fine masonry of the inkas, that must be about the narrowest range achievable with the methods available.

The risk of being in error in using the one-sigma ranges is 1 in 3. Using two-sigma ranges means that the risk is lowered to 1 in 20. If we use the two-sigma ranges and discard the possibility of the stonework being made after the 1530's, then blocks were transported on the valley floor *c.* A.D. 1420–1530's. The temple ramp was constructed *c.* A.D. 1430–1530's, and one period of use or construction in the temple area was *c.* A.D. 1470–1530's.

The samples that were recent need a comment. My interpretation of the thin layer of grass, twigs and roots under the Inkaqonqorina block is that it formed after attempts were made to move the block during the work on the motor road. An air pocket left enough room for some vegetation to grow. The two recent samples of charcoal from the temple area are the result of visits to or work at the ruins in late historical times, and apparently the culture layer there has been disturbed by those activities.

There is a difference in age between the two samples from *ch'ullpa* no. 2. One explanation may be that the wall was mended and new grass used several hundred years after its original construction. Another explanation may be that the difference is due to a laboratory error. A third possibility, and the one I find the most plausible here, is that some charcoal particle with a higher age was dated together with the grass of sample AA-1407B. I have noticed that charcoal particles are often present in the *ch'ullpa* walls, but unfortunately the sample was not sieved before submission. The sample that was later submitted to the laboratory in Uppsala (Ua-1709) was sieved in water before submission, only the *ichu* grass being sent. I would suggest that the running of that sample (Ua-1709) has provided us with a more reliable date.

One of the four grave-houses yielded an age almost identical to that of the trunk under the Inkaqonqorina block, and two more—the two with the same values—were built during that same time span, according to the calibrations, or within one generation before. That is indeed interesting, as it makes it probable that such grave-houses were indeed built when the stonework was executed. This means that we should reckon with the possibility that stoneworkers or their relatives or neighbours were actually placed in them. It should be pointed out that the grave-houses differ in shape and, of the two with identical values, *ch'ullpa* no. 35 is rectangular in shape, while no. 33 is rounded and slightly oval. The rectangular, architectural form is typical of the inkas (Gasparini & Margolies 1980:191; Kendall 1976*a*:22). Rounded house plans, on the other hand, are regarded as non-inka, representing either regions that were not incorporated in the empire or pre-inka sites (Hyslop 1990:247). However, Hyslop recognizes that round burial structures in the Lake Titikaka region continued to be built under inka domination (1977:155; 1990:248). As far as can be judged from the Kachiqhata evidence, there

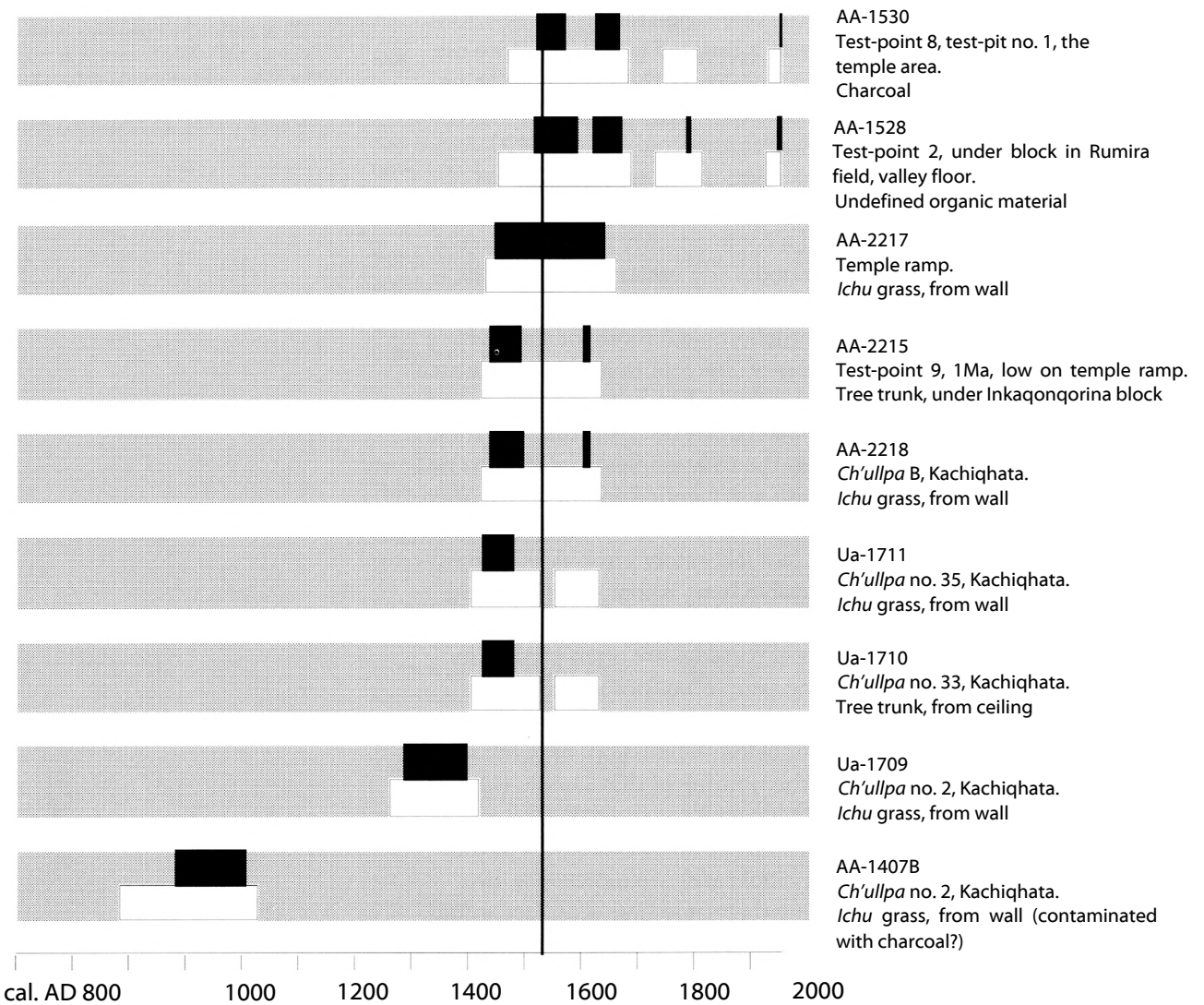


Figure 71.
Diagram showing the ^{14}C results from the investigation area. One-sigma ranges are in black and two-sigma ranges in white. The vertical line marks the 1530's.

is no time difference between the rectangular and rounded forms, and both were built and in use in inka times.

Ceramics

Most of the ceramic finds in our investigations were classified by Sara Lunt. Unless otherwise stated, the summary and evaluation below are based on her work. She had no access to information on the context of the finds at the time of her classification. This was done so as to avoid the biases produced by expectations due to association with other features.

Lunt bases her classification on evidence from excavated sites at Cusichaca, about 20 km, as the crow flies, down the river from Ollantaytambo. The terms used by Lunt refer to styles, and they do not necessarily imply a date. Cusco/classical inka ceramics are probably imports from the Cusco region. Pottery referred to as inka ceramics, on the other hand, were probably made by local potteries, following the "classical" fashion. The term "pre-inka" is used for pottery of a type that was in circulation by the Late Intermediate Period but may be earlier (see the chronological chart in Table 2). Some of the pre-inka wares continued to be made, and were certainly used, in the Late Horizon.

At test-point 5, the storage space and workshop below the rock-slide in the western rock-slide area (Figures 29 and 30), a total of 130 ceramic fragments were recovered from the bottom level of the blocks there and deeper down. Some of these sherds were tiny and could not be classified. With one exception, all the sherds that could be assigned to one single period were from the Early Horizon. The exception was a sherd of a type which was in circulation by the Late Intermediate Period but which may be earlier. Most of the classified fragments were of Chanapata type or of probable Chanapata type. The sherds were eroded and thought to be residual by Lunt, but I believe that most of them lay roughly *in situ* and that they represent a settlement on the spot.[1] The site is on a shelf high up on the Kachiqhata slope, at about 3,425 m a.s.l. Its location in the uplands corresponds well to the location of the Early Horizon site at Huillca Raccay above Cusichaca (Hey 1984). There is consequently no connection between the ceramics and the stonework other than the physical proximity. The settlement is worth a study of its own, as little is still known about the Early Horizon in the Cusco department.

Test-point 6, a workshop in the western rock-slide area (Figures 21 and 22), yielded no potsherds. At test-point 7 by the block on the workshop terrace in the northern rock-slide area (Figures 17 and 18), 22 fragments lay on the surface right by the block's northern side, in the trench we opened up there. The sherds classified included inka; possibly and probably inka; inka ware with an unusual design; and possibly inka period with a pre-inka design. It appears that soil accumulation in the rock-slide areas is very slow. Sixty centimetres away from the block were another 10 fragments, lying superficially in the ground, down to a depth of 5 cm. These were classified as inka; probably inka; and inka, possibly provincial. No sherds were found in the trench along the eastern side of the block. Judging from the results, the ceramics may have been deposited or damaged at the spot when the stonework was executed. One possibility is that the sherds are from vessels used for serving food and drink to the workers; another possibility is that the vessels were placed by the block in ceremonial acts.

As for the valley floor, no ceramics were found associated with test-point 1, where one trench was excavated by a deeply buried block and another between two blocks in the same field. At test-point 2, also on the valley floor, a very large block was lying half-buried with one end in a lynchet (Figures 48 and 49). Eleven ceramic fragments were recorded. They were classified as deriving from a group in which the nearest style was Cusco/classical inka; from a group of coarse, quartz-tempered and other cooking pots, or "domestic" inka; and as Late Intermediate Period in style with affiliations to Killke/Killke-related pottery. All the fragments lay deeper than the bottom level of the nearest end of the block, 145–180 cm below ground. This indicates that the Cusco/classical inka ceramics were in use before the time of transportation. I believe the sherds were deposited where they were found by soil creep, possibly from remains which, judging from crop marks, seem to be present below ground in the field by the block.

Test-point 9 was at the Inkaqonqorina block on a low section of the temple ramp (Figures 52 and 53). Sherds from the previously excavated trench on the eastern short side of the block were not recorded. The 14 fragments from the trench on the south-western long side were classified as inka; inka, classical or provincial; inka, probably classical; inka, possibly classical; and pre-inka. The trench reached a depth of about 20 cm below the bottom level of the block. Some of the sherds were clearly from the ramp's infill. We may therefore conclude that inka-style ceramics were in use before the time of transportation.

The ceramic finds from our excavations in the temple area are treated together here, and they include finds from test-points 3, 4 and 8 (Figure 61). A total of 54 sherds were recorded. Most of the pottery was found at test-point 3 and in test-pit 11 at test-point 8. All in all, it was classified as Cusco/classical inka; inka; "local" inka; probably inka; possibly inka; and Late Intermediate Period style with the closest affiliation to Killke/Killke-related pottery, one of which may be provincial inka or early inka. There was one post-conquest sherd among the finds, one with a glaze. The classical inka and inka sherds clearly predominated. The few, Late Intermediate Period style sherds were not distinguished stratigraphically, either because the vessels were used at the same time as the inka vessels or because the soil had been disturbed or—as I would assume to be most likely—because of a combination of the two factors. It seems that, although the soil had been disturbed by soil creep and by activities in historical times, the ceramics in the temple area had almost exclusively been deposited there by late inka times. It should be noted that, although this was most probably a temple area, there were sherds from cooking pots that are almost certainly inka among the finer wares. Perhaps stoneworkers were served food and drink from some of the vessels.

If we turn to the grave-houses on Kachiqhata, there are some ceramic sherds on the surface associated with them, that is, within the grave-houses and outside their doorways. Most of those encountered were inka, but a few remain unidentified. By one chamber there were sherds with a Lucre design. *Ch'ullpa* no. 2, most probably constructed in the Late Intermediate Period, contained both non-inka and inka sherds. It seems, then, that the gravehouses on Kachiqhata may have been used repeatedly or a dead person in them venerated over an extended period of time. At the dated *ch'ullpa* no. 33, we found only inka sherds, and that is in accordance with the ^{14}C dating of its construction. The identification of pottery from the grave-houses was made by Alicia Quirita H. No ceramics were found on the surface within or outside the doorway of the dated *ch'ullpa* no. 35 or by the undated *ch'ullpa* no. 34.

Observations of relative age

The age of stone buildings and of prepared block surfaces can in some cases be dated by lichenometry. One way of using the method is to compare the relative ages of features. Lichenometry has been employed for studies of such diverse features as the advances and retreats of glaciers, and the age of hill-forts, masonry walls, cairns, ovens and stone mazes (labyrinths) (see, for example, Broadbent 1987*a*, 1987*b*; Follmann 1961; Karlén 1973, 1975; Lindman 1988). The basis of the method is that there are crustose lichens which grow quite symmetrically and at a steady and slow rate.

There are crustose lichens growing on blocks in the rock-slide areas of Kachiqhata. My observations suggest that lichens of the same species[2] tend to differ in size on blocks in the western and in the southern rock-slide areas, the ones in the western being slightly smaller. If this is correct, then the exploitation of the southern rock-slide area started before the exploitation of the western. This is in line with my impression that the ramps in the rock-slide of the western area were more hastily executed than those in the southern (see section 2.4 on "Transportation"). Furthermore, the western is the one furthest away from the only known destination at the settlement of Ollantaytambo, and it contains larger amounts of boulders than the southern and northern areas (see section 2.1 on "Raw material"). It seems that, of the three rock-slide areas, the western was the last to be exploited.

One clear example of the superposition of features is at the temple ramp. On the ramp, four houses were built (Figure 72). They constitute obstacles to any further transportation of blocks up the ramp. Consequently, they were built later than the block transportation. Within the houses, there are inka ceramics on the surface. Further down the ramp,

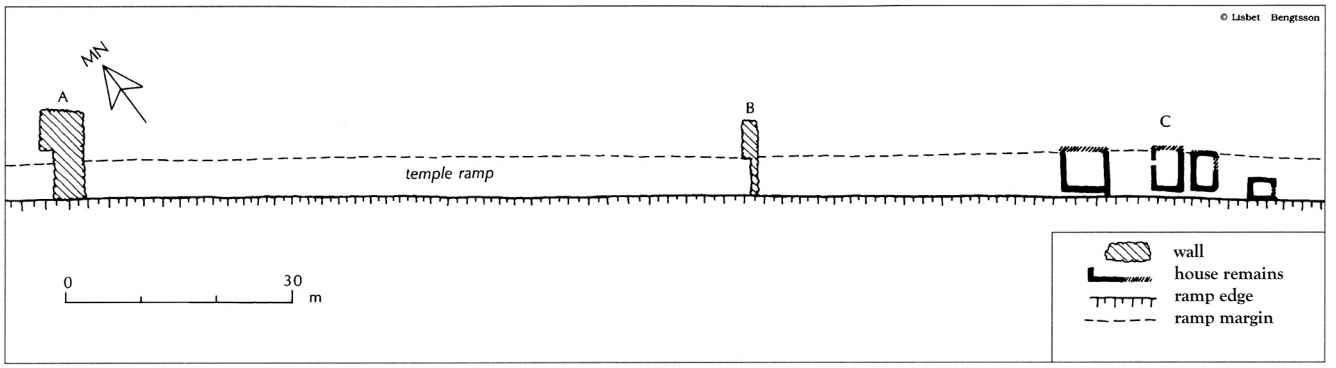


Figure 72.
Two walls (A and B) and four house remains (C) on the temple ramp. The buildings effectively obstructed any further transportation of blocks up the ramp.

there are two more obstacles in the form of walls built on top of the ramp and crossing it (Figures 72 and 73). They effectively cut off the access to the temple area. One possible explanation for the constructions on the temple ramp is that they were built during Manco Inka's stay in Ollantaytambo in the 1530's. He fought the Spaniards there and had reason to cut off any access to the points from which they could defend themselves (see Pizarro 1986:146–147 [1571:Ch. 20]).

Figure 73.
One of the walls built on top of the temple ramp and crossing it. Facing SE.

[1] The finds included bones. Some of them and a tooth lay together with several sherds, most of which were probably from the same vessel. I believe the bones were originally placed in the vessel, which was set into the ground. An identifiable navicular bone was from the knee of a deer. The tooth was from a brocket deer (genus *Mazama)* (identification by courtesy of Björn Broo). Brocket deer still graze the mountains nearby.

[2] One of the two types measured could be determined as *Diploschistes* sp. The determination was made by Lars Arvidsson, at the time at the Museum of Natural History in Göteborg.

3.2 Organization of labour in inka society

The organization of labour in inka society includes various forms, such as the *mitmaqkuna*, *kamayuqkuna*, *yanakuna*, *aqllakuna*, *mink'a*, *ayni*, and the *mit'a* labourers. Not all these forms were mutually exclusive (Rowe 1982:96; Villanueva 1970*a*). The *mitmaqkuna*, *kamayuqkuna*, *yanakuna*, and *aqllakuna* were closely linked to the inka state, to the state religion or to individual leaders. The *mink'a* and *ayni* were reciprocal forms of labour within the local community, the *ayllu*. The *mit'a* labourers held an intermediate position and were normally members of the local community who, for part of the year, gave labour service to the inka state. There are indications that the systems of *mitmaqkuna* and *yanakuna* were established in some regions prior to the inka domination, although they were not necessarily denoted by these terms (Murra 1975:227–228, 232). Also the *mit'a* is thought to be a pre-inka form of labour (Hastings & Moseley 1975; Kolata 1993:214, 223; Moseley 1992:165, 183, 223, 258). This may well be the case with the other types of labour as well. While large-scale resettling, such as the *mitmaqkuna* represented, may certainly have left traces in the archaeological record, organizational forms on the community level, such as *mink'a* and *ayni*, can hardly be demonstrated to have existed, if not by oral tradition still alive during the colonial times. At the same time, both represent reciprocity, a social institution with ancient roots (Rostworowski 1976).

The term *mitmaqkuna* (or *mitimas* or *mitimaes)* can be translated as "immigrants" and they were people re-located from their homelands, in some cases to distant regions (see, for example, Wachtel 1982). This was a policy carried out by the inkas to ensure political stability, to spread the Quechua language, and to exploit certain resources—such as maize and coca—to feed the army, for use in ritual, etc. Although the *mitmaqkuna* are usually referred to as a stable population in their new locations, there are also cases, in which members of a *mitmaq* population were replaced (Espinoza 1973:286).

A *kamayuq* was someone who had a special function, knowledge or ability in inka society. He could be a skilled labourer, an artisan or someone in charge of specific duties. According to Guaman Poma, special decrees were proclaimed by the Inka ruler Tupa Inka Yupanki, together with other authorities of the state. These decrees specified the state officials who were to carry out particular duties. The list includes various specialities with the *-kamayuq* epithet, examples of which are *quiro camayoc* (carpenter), *conbi camayoc* (embroiderer, weaver of fine cloth), and *quilca camayoc* (a "designer" of knotted strings, the mnemonic de-

vice) (Guaman Poma 1980:165 [1615:191 [193]]).[1] Exceptionally, women may be distinguished as officials by the epithet *-kamayuq*, such as the *uicza allichac hanpi camayoc* (the female healer, who cures upset stomachs) (Guaman Poma 1980:166 [1615:192 [194]]). We must consider that the position of skilled labourers and others with specialized knowledge was different before they were promoted to be officials in the expanding state. The epithet *-kamayuq* was certainly not limited to the state officials and had a value of its own. Thus, for example, a dog which was a great biter (that is, a dog which "knew well" how to bite) was a *caniycamayoc alco*, and someone who ate too much and therefore swelled (that is, someone who "knew well" how to eat) was a *micuspa pananana y camayoc* (González 1989:50, 277 [1608]). The officials included *pirca camayoc*, translated as *albañiles*, that is, masons, a piece of information given by Francisco Falcon in 1571 (Rostworowski 1975:335).[2] Falcon refers to the officials as serving the Inka ruler (and not as serving the state), but there is not necessarily any conflict between the two, since the Inka ruler can be said to personify the state (but cf. Rostworowski 1962). Falcon states that the masons were provided both from the coastal lowlands (*los llanos Yungas*) and from the highlands (Rostworowski 1975:335).

The *yanakuna*, forming a servile population, were personally or as families attached to a leader, a household or a lineage (Murra 1975:241; Rowe 1982:96–102). They were used by leaders for their personal service. The leader could be an Inka ruler, an official of the central government or a provincial leader (*kuraka*). Some were instead linked to the service of mummies, others to the service of the state cult. Some of the *yanakuna* held a high status in inka society and could be *orejones* (with pierced earlobes), that is, they belonged to the inka elite class (Rowe 1982:99). They could also be rewarded with responsible administrative posts (Rowe 1982:100).

Aqllakuna means "the chosen ones". Normally, the *aqllakuna* were women, in contrast to the *mitmaqkuna*, *kamayuqkuna* and *yanakuna*. The *aqllakuna* women lived in seclusion and worked in the service of the Sun or state cult. Their work included the weaving of exquisite garments and the production of maize beer. Also boys chosen to be sacrificed were called *aqllakuna*.

Mink'a refers to hiring someone to help. It implied (and implies) a reward or compensation for the help given, but that compensation may be given in a different kind (González 1989:240 [1608]; Rostworowski 1976). Today, the *mink'a* may include a group of ten to fifteen or twenty workers hired for agricultural work or for such a task as laying a new roof on a house. In exchange, the workers are served coca, food and drink (*chicha* and rum). While such workers are male, those who prepare the food and *chicha* are female (Skar 1982:216–217).

To work in *ayni* was (and still is) a form of reciprocal labour service, in which a service performed by someone (often within the *ayllu*, that is, the kinship or local group) is returned at a later date by the receiver in the same form. In the village of Matapuquio in the Department of Apurímac today, *ayni* is a service, in which it is agreed in advance what type and amount of work will be involved. Days of work given and received are calculated carefully, and the types of work will be roughly correlated (Skar 1982:213). The participants are often neighbours and at the same time distant relatives (Skar 1982:214).

Both *mink'a* and *ayni* are basically local and reciprocal forms of labour. They were quite certainly used in an unofficial way in the inka state. For example, when someone performing *mit'a* (the rotational service) became ill and needed to be replaced, *ayni* may have been used. Individual Inka rulers seem to have used *mink'a* on occasions, when they needed help from provincial or local leaders, as in a military campaign (Rostworowski 1976).

Mit'a means "season, time for, shift", in Quechua. *Mit'a* labourers worked on a rotational (or occasional) basis in public works, such as road construction and provision for the storehouses, including agricultural work on state lands and on the lands dedicated to the state religion (see D'Altroy & Earle 1992:38–39 for a more elaborate review of tax extraction, and Murra 1975 for further details). Those involved in *mit'a* were provided with the tools they needed for their work (Murra 1975:31). The people from whom such labour was extracted for these tasks were the *hatun runa*, also called *suyu runa* (Murra 1975:33; Rowe 1982:97). They were the able, adult men aged between about fifteen and fifty years of age.

Women and children were not registered as taxpayers or *hatun runa*. At the same time, they worked within the obligations of the *hatun runa* of the family. Textile production, for example, was a task mainly performed by women. This formed part of a *mit'a* obligation to the state (Murra 1975:156).

Mit'a was normally performed by the local population. They would normally be peasants but worked part of the year on the state lands or for the state religion. The work could include herding the Cusco camelids, weaving, and gathering the produce of forests and lakes (Murra 1982:257). Also people from other provinces could be used for *mit'a*. That *mit'a* labourers sometimes worked away from home is exemplified by the Visita de Huanuco. From there, people were sent even as far as Cusco (about 600 km away) to work for the Inka ruler, including work on house construction (Ortiz de Zúñiga 1920:33, 39, 171 [1562]; also see section 1.2 on "Previous research and present state of knowledge"). That they were not *mitmaqkuna*, although so far away from home, is clear from the fact that they continued to be considered as taxpayers in Huanuco

and were registered on *khipu* (a knotted string record) there. There are some indications that such an assignment away from home could result in a subsequent loss of that part of the population from the record of their homeland.

[1] The pagination in brackets refers to the revised pagination made by Murra and Adorno.
[2] For the different terms used for stone and stonework in colonial times, also see van de Guchte (1990:323–328).

3.3 Groups in Ollantaytambo possibly involved in the stonework

I have succeeded in locating only very little, documentary, published information that deals with Ollantaytambo from the time shortly after the conquest. We will proceed to look at what evidence there is, on the whole, on different groups in Ollantaytambo and close by.

The information from post-conquest times is relevant to this study, in so far as it gives us indications of the social, economic and political structure of Ollantaytambo in inka times. Of course, care must be taken not to project directly any evidence from the mid or late 1500's onto inka society or to use any such information as proof of how Ollantaytambo was organized in inka times. As noted in section 1.3 on "Ollantaytambo and the investigation area", people were moved into the trapezoidal settlement in the 1550's. Another factor to be considered is that the inka state certainly underwent many changes during its short existence. Therefore, any information valid for, say, the last generation of the inka state at a specific place does not necessarily reflect the situation one or more generations earlier. My aim here is to look at what little information there is and to try and evaluate its relevance to the stonework.

Ayllus

If we turn to the *ayllus* which Ollantaytambo was composed of, some information can be extracted. An *ayllu* can be defined as a kin group or a social group. The *ayllu* concept has been and is applied to different levels and on different scales. In the village of Matapuquio in the Department of Apurímac today, the moieties *hanay* and *uray* are referred to as separate *ayllus*. In relation to other villages, however, the whole village is considered to be one *ayllu* (Skar 1982:218). At the time of the general *visita* (inspection) of Viceroy Toledo (in 1572), the *ayllus* of Ollantaytambo numbered four. They were reported as Cusco, Chinchaysuyo, Araccana and Yanaconas (Clave & Remy 1983:7). Furthermore, in an earlier document, a Qolla *ayllu* is mentioned (see below). Their names tell us something about their history.

I would suggest that the Cusco *ayllu* was formed by inhabitants of the inka capital, who were members of either the nobility or the army, or both. According to the drama entitled "Ollantay", the Qosqo *ayllu* had its origin in the army sent from Cusco to fight the general Ollantay (Zuidema 1963–1964:352). The drama was written down in Quechua in the mid 18th century but has its roots in inka times. It was recorded by the priest Antonio Valdez, who was from Urubamba, about 20 km from

Ollantaytambo and in that same major valley. The eastern section of Ollantaytambo where the trapezoidal settlement is located is still called Qosqo *ayllu* (Angles 1978:2; Martínez 1971:27).

With a Cusco *ayllu* mentioned for Ollantaytambo, it makes sense that we should also find a Chinchaysuyu and a Qolla *ayllu*. Their names suggest an organization at the time of the Toledan *visita* that was influenced by that of the inka capital, Cusco. Cusco's four sectors carried the same names as the four parts of the empire, with Chinchaysuyu and Antisuyu forming the upper moiety (*hanansaya*) and with Qollasuyu and Cuntisuyu forming the lower moiety (*hurinsaya*).

An organization reminiscent of that of inka Cusco has survived to the present day in various villages around Cusco. When Tom Zuidema conducted fieldwork in the 1950's, he found that Acos, a village about 50 km south-east of Cusco, was divided into *hanansaya* and *hurinsaya*. The *hanansaya*, or upper moiety, *ayllu* bore the name of Cusco. The *hurinsaya*, or lower moiety, *ayllu* bore the name of the whole village, that is Acos (Zuidema 1964:97). If we transfer this scheme to Ollantaytambo, the aforementioned Qosqo *ayllu* would represent the *hanan* or upper division, while the *hurin* or lower division would carry the name of the settlement itself. As noted in section 1.3 on "Ollantaytambo and the investigation area", there was a name of *tambo* in that other section of the settlement in colonial times, namely in Manyaraki Square (Glave & Remy 1983:3). This name is said to refer to the location of a road station. Possibly the name in that sector referred to both a practical function *(tambo)* and a social segment (Tambo representing the local population of the settlement).

The Chinchaysuyo *ayllu* in Ollantaytambo would have been related to Chinchaysuyu, the north-western part of the empire (Figure 74). The members of the Chinchaysuyo *ayllu* were possibly *mitmaqkuna*, that is, a group or groups resettled after the conquest of their home territory by the growing inka empire, or, as Glave & Remy (1983:8) suggest, were former members of the Ayarmaca (see below).

The Araccana *ayllu* at Ollantaytambo was possibly associated with Antisuyu. Zuidema suggests that its name, also written as Araccama and Araqama, is an alteration of Ayarmaca (but cf. Glave & Remy 1983:9). In Cusco, the Ayarmaca apparently lived in the Antisuyu section of the town. We can again make a comparison with the drama entitled "Ollantay", in which the general who fought the Inka ruler was specifically a governor of Antisuyu (Zuidema 1963–1964:349, 352). Perhaps the association of Ayarmaca with both Chinchaysuyu (as Ayamarca) and Antisuyu (as Ayarmaca) in Bernabe Cobo's account (1990:58, 68 [1653:Bk. 13]); also see Rostworowski 1993*d*:256–257) implies a degradation in their position from the higher-ranking Chinchaysuyu from the time before they were incorporated into the inka state (the ninth *huaca*

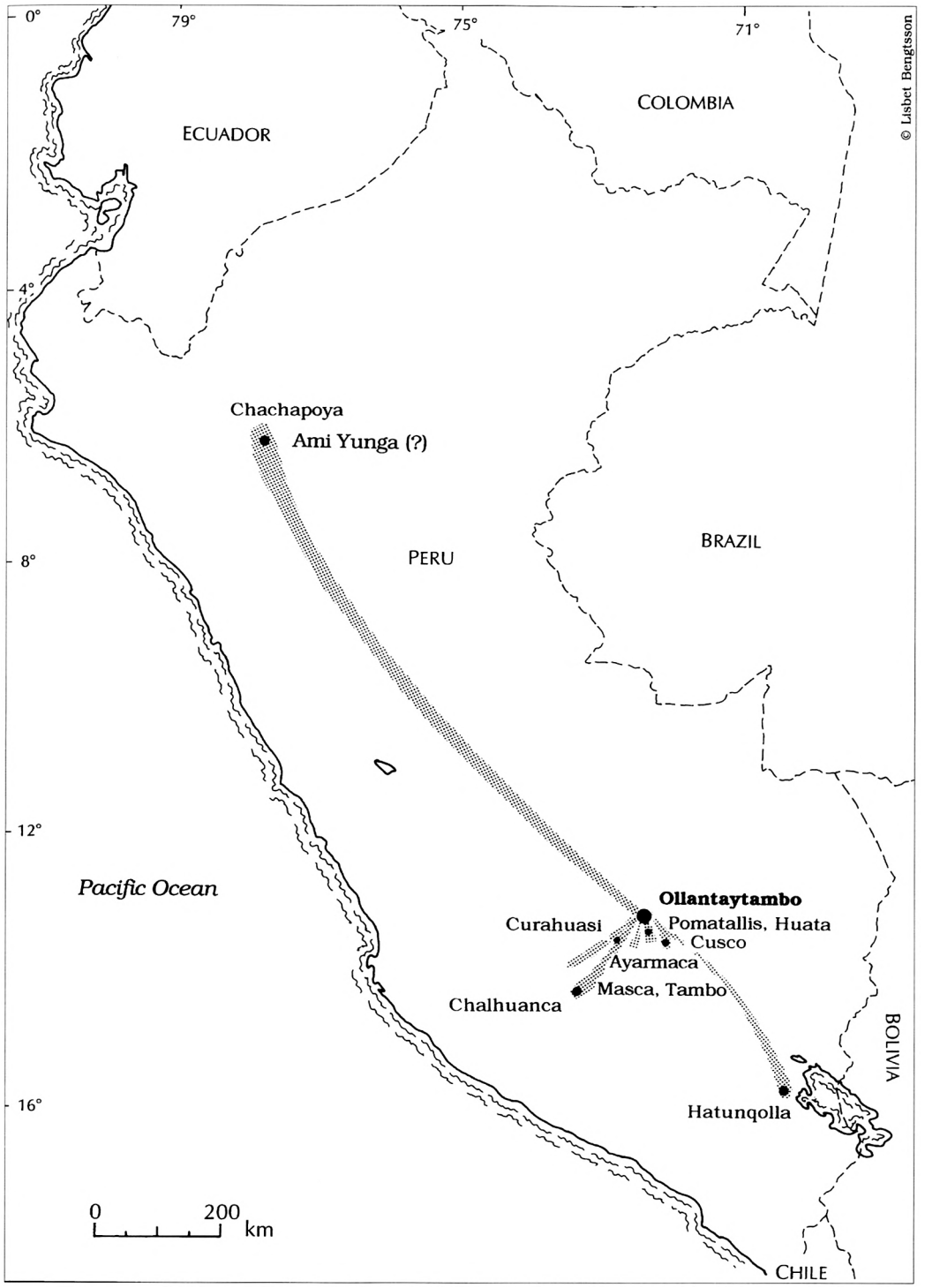


Figure 74.
Origin of native groups in Ollantaytambo in the 16th and 17th centuries. Hypothetical reconstruction based on written sources.

or shrine on the fifth *ceque* or imaginary line, which was their mythical place of origin) to the lower-ranking Antisuyu once they were conquered and given a place within the state (the eighth *ceque*)? The western section of Ollantaytambo, where Manyaraki Square is located still carries the name of Araqama *ayllu* (Angles 1978:3; Martínez 1971:27).

The fourth *ayllu* mentioned for Ollantaytambo at the time of the Toledan *visita* was the Yanaconas *ayllu*. The name *yanakuna* refers to the personal staff of a leader, household or lineage. The *yanakuna* of Ollantaytambo were not necessarily from only one so-called ethnic group. In evaluating the origin of the Yanaconas *ayllu* at Ollantaytambo, special care must be taken, since the Spaniards had an interest in having servants and often not only "transformed" former *mitmaqkuna* into *yanakuna* but also exaggerated their numbers during the inka reign (Espinoza 1973:251; Rowe 1982:98). On the other hand, it appears that former *yanakuna* could be regarded as *mitmaqkuna* by the Spaniards as well (Murra 1975:232–233). For the valley of Yucay, the Spaniards acquired people elsewhere, brought them to the valley and used them as "*yanakuna*" there (see Rostworowski 1970:263). The valley of Yucay corresponds to a section of the Vilcanota Valley upstream from Ollantaytambo.[1] We also know that Indian leaders took advantage of the situation, when *yanakuna* lost their master and pretended that those *yanakuna* belonged to them. That augmented the Indian leaders' own prestige and wealth and to a certain extent also helped the *yanakuna* themselves, who otherwise would have been compelled to pay tribute to the Spaniards, as taxable peasants. One possible consequence of this might have been that other groups or *ayllus* had already been incorporated into the Yanaconas *ayllu* at Ollantaytambo by the Spaniards before the time of the *visita* in 1572.

Apart from the four *ayllus* at Ollantaytambo noted in the 1570's, Glave & Remy tell us about the *ayllu* formed by the "Collas Mitimaes" who, according to one document, were still working the lands of Collcabamba at Ollantaytambo in 1555 (Glave & Remy 1983:7).[2] They had already disappeared from the record at the time of the Toledan *visita*. These were probably the same people, then, that formed the Qolla *ayllu*, which existed at Ollantaytambo up to at least 1560 (Protzen 1993:269, n. 1).[3] One reason for their disappearance from the record may have been that the members of the Qolla *ayllu* had been incorporated into the Yanaconas *ayllu* by the Spaniards before the time of the Toledan *visita*. Another reason, and maybe a more probable one, is that they had returned to their homeland, the Qolla territory in the Titikaka basin, after the inka control had ceased. It was not uncommon for a group of *mitmaqkuna* to return to their place of origin after the inkas released their control. This is reported, for example, from the Pachachaca and Abancay (formerly Amancay, in inka times called Aucapana) Valleys (Espinoza

1973:286) and from the Cochabamba Valley in present-day Bolivia (Wachtel 1982:220). In the case of Ollantaytambo, it would have occurred sometime between 1560 and 1572. In the case of Pachachaca and Abancay, by 1566 90% of the *mitmaqkuna* present in late inka times had left (Espinoza 1973:233–234, 256). Maybe some of the Qolla *mitmaqkuna* at Ollantaytambo turned back to the *altiplano*, and others died of diseases brought by the Spaniards, while any remaining members were absorbed into another and larger *ayllu*. It would not be the only case in the Cusco department, in which one *ayllu* was at some point absorbed into another for demographic reasons (see Urton 1990:86).

One rare example of reference to the stonework in the written sources is presented by Sarmiento. He tells us that two sons of a great ruler from Collao in the Lake Titikaka region were engaged in the construction work of the "very sumptuous buildings" of Ollantaytambo. They participated as captives, after their father had been killed in a battle by the Inka ruler Pachakuti (Pachakuti Inka Yupanki). One night, the two brothers escaped, together with all the people there (Sarmiento 1988:112 [1572:Ch. 40]). If this reference relates to a true event, the Qolla *mitmaqkuna* living at Ollantaytambo in 1555 had stayed on when the rest of the group left or they had arrived at Ollantaytambo at a later date than the event, and thus at a later date than the stonework.

The mention of Qollas as *mitmaqkuna* at Ollantaytambo can also be related to the name of the settlement as that of Collatambo, Collartambo or Collaytambo in 1555 (Glave & Remy 1983:2, 7). Maybe the Qollas had formed an important segment of the population there.

Groups not named as ayllus

Although Glave & Remy do not tell of other *ayllus* at Ollantaytambo than the ones noted above, they do mention that there were Chachapoyas, Ami Yungas, and Quechuas Chinchaysuyos at Ollantaytambo, when the Qolla *mitmaqkuna* were there (Glave & Remy 1983:7). All these groups were most probably *mitmaqkuna*. Both Chachapoyas and Ami Yungas are also referred to in a testament of 1590 dealing with the Amaybamba valley, which is close to Ollantaytambo. The Chachapoyas and Ami Yungas there were *mitmaqkuna*, placed there by the Inka ruler Tupa Inka Yupanki (Rostworowski 1993*a*:163). The region from which the Chachapoyas came was in the mountains far to the north (east of Cajamarca) (Figure 74). I do not have the knowledge to identify the Ami Yungas present in Ollantaytambo, but it can be inferred from their name that they were foreign to the area, *yunga* meaning "lowlands". Since they are named together with the Chachapoyas, and both groups are said to have been placed in the Amaybamba Valley by the same Inka ruler, the Ami Yungas may have come from a region adjacent to that of

the Chachapoyas. Rostworowski (1993*a*:149) suggests that they were from the Ecuadorian coast but presents no arguments for the case. There was a close connection between the Amaybamba Valley and Ollantaytambo. Amaybamba represented an ecological complement to Ollantaytambo, being located on the other side of the Vacaybilque pass (later known as Panticalla and as Abra de Málaga) in a lower valley, now part of the province of La Convención (Glave & Remy 1983:11). Amaybamba also had links with Cusco and had members of the inka nobility, descendants of Wayna Qhapaq, living there (Glave & Remy 1983:11).

According to oral tradition, the Chachapoyas region was incorporated into the empire during the Inka ruler Tupa Inka Yupanki's reign, but only after fierce fighting (Garcilaso *c.* 1980:3:80–81 [1609:Bk. 8, Ch. 2]). Later, the Chachapoyas revolted without success. Although Garcilaso tells us that they revolted only once, during Wayna Qhapaq's reign (Garcilaso *c.* 1980:3:153 [1609:Bk. 9, Ch. 7]), Schjellerup mentions more than one revolt (Schjellerup 1984:161). It seems likely that the Chachapoyas at Ollantaytambo were a group re-located after battles or uprisings in their home territory. This may also explain why there was no *ayllu* named after the Chachapoyas during the Toledan *visita*. Some of the *mitmaqkuna* from the Chachapoyas region living in the nearby Amaybamba valley are known to have joined the Spaniards to search for Manko Inka in Vitcos (about 80 km to west-north-west of Ollantaytambo, as the crow flies) in the 1530's. Others had fled to their homes (Rostworowski 1993*a*:165–166).[4] Manko Inka had been crowned "Inka ruler" by the Spaniards but turned against them. Before leaving for Vitcos, Manko Inka fought at Ollantaytambo against the Spaniards and their collaborators. People from the rainforest participated in the fighting on Manko Inka's side and were used as archers by him (Hemming 1983:214). Suggestively, these people came from the lowlying parts of what is now the Cusco department to the north or east, or from the Madre de Dios department further east. People from those regions are not known to have lived in the valley either before or after the revolt.

The Quechuas Chinchaysuyos at Ollantaytambo probably included people from Omasuyu and Curahuasi, who were said to be present in Ollantaytambo (Glave & Remy 1983:8). Omasuyu and Curahuasi lay in the core of the Chinchaysuyu quarter of the inka empire, as did the lands of the Cotapampas, Yanahuaras and Jaquijahuanas or Ayarmacas (Espinoza 1973:227). The Quechuas Chinchaysuyos at Ollantaytambo may furthermore have included people who had lived close to Chalhuanca, within what in the 16th century was known as the province of Aymaraes and Quichuas (Glave & Remy 1983:138). Chalhuanca is an affluent to the Pachachaca River and thus pertained to Chinchaysuyu. This region is south-west and west-south-west of Ollantaytambo and about 80–150 km away. Espinoza tells us that the "Quechua kingdom of

Chinchaysuyu" included the Pachachaca and Abancay Valleys and Curahuasi and Sayhuitca. The Quechuas were known to speak *runa simi*, now also known as the *Quechua* language. After the inkas conquered the Quechuas of the Pachachaca and Abancay Valleys, they were moved to different parts of the growing empire, including Cajamarca, Huamachuco, Chupaychu and Copacabana (Espinoza 1973:230). Their new locations ranged, then, from what are now the northern highlands of Peru to Lake Titikaka in the south. I would suggest that the presence of Quechuas Chinchaysuyus at Ollantaytambo was a result of a re-location carried through by the inkas. According to oral tradition, the Quechuas of the Abancay–Andahuaylas region had earlier been conquered by the Chancas (Cieza 1986:254 [1553:Ch. 90]; Espinoza 1973:242) and lived under their domination. The Chancas were themselves later defeated by the Inka ruler Pachakuti Inka Yupanki. On the one hand, if these events really occurred, the Quechuas Chinchaysuyus may well have considered themselves to have been liberated once the inkas conquered them and therefore felt loyal to them. On the other hand, it is somewhat intriguing that the Quechuas Chinchaysuyus—and not only the Chancas—should be moved by the inkas to a place so close to the capital of the empire as Ollantaytambo. If they were considered to be very loyal to the inkas, one would expect them to have been moved further away from their region of origin or to have been moved to a region with uprisings, as a stabilizing factor.

Apparently, there were links between Ollantaytambo and other groups as well. Glave & Remy point to the fact that the Antas and the Tampus of Ollantaytambo had a close relationship (1983:5). The Anta valley lies about 20 km away from Ollantaytambo as the crow flies. In 1572, one village founded during Toledo's *visita* to Chinchaysuyu was San Martín de Quilliscache, in the Anta Valley. We know that in 1567 there were still members of the Quilliscache group living in the gorge between Anta and Pachar, that is, the gorge that connects the valley of Anta with the Vilcanota Valley. In 1647, members of the Quilliscaches reportedly lived at Huarocondo at the beginning of the gorge (Glave & Remy 1983:5), and this is the case even up to our own century (Zuidema 1964:152). The Quilliscachis had a special position within the organization of Cusco. From this group, the inkas chose their messengers, spies and policemen (Zuidema 1963–1964:351). One member of that group, Urco Huaranga, whether by coincidence or not, plays an important role in the Quechua drama entitled "Ollantay". Another important figure in that drama is Flanco Huallu, a former Chanca chief.

Ollantaytambo and Pachar certainly had close links in inka times. Pachar is located 4 km up the Vilcanota River from Ollantaytambo. Vestiges of those connections include agricultural terraces, irrigation channels, canalized sections of the river, buildings and other remains, and

they are present all the way between the two; furthermore, an inka road connects them (Astete 1952:217; own observations). There is also an indication of a social link in the name of a set of terraces at Ollantaytambo, namely Pomatallis. Pomatales is an alternative name for the Pachar gorge (Astete 1952:216; Glave & Remy 1983:1).[5]

The set of terraces named Pomatallis are just by and below the temple area at Ollantaytambo. They had a special setting, because to reach the temple area from the direction of the settlement and to reach the groups of houses on the same spur, as well as the place for the dead there, one passes right by these terraces on a long flight of steps and even partly right through them.

Yet another link between Ollantaytambo and the gorge between the Anta Valley and Pachar can be inferred from the toponym of Huatabamba at Ollantaytambo. In colonial times, it was the name of an estate later to be called Compone and now a production co-operative named Capac Inca Ollanta. Huatabamba is also the name of a set of agricultural terraces, where the houses of the estate were built and still stand. In conformity with tradition, the Huatas once had a small kingdom but were defeated by the Tampus (Glave & Remy 1983:3). The Huatas were a group that are being associated with remains of a fortified site above the Pachar gorge. The remains are still to be seen, and the site itself is called Huata. The site has been described by Angles (1988:1:437–446), Kendall (1974*b*:2:344–349), and Rowe (1944:53), among others. It has surface residues from various periods, the earliest being the late Early Horizon (Chanapata) (see Table 2 in the "Introduction" to this study). Kendall suggests that the site was continuously occupied from the end of the Middle Horizon to the Colonial Period. This includes the Late Intermediate Period, which would be the period during which the Huatas would most likely have been defeated.

Another set of terraces with a name referring to a group of people is that of Mascabamba, a name that was also used for a colonial estate (Glave & Remy 1983:3). Mascabamba is located at the entrance to Ollantaytambo from the direction of Cusco, close to the rock painting of Inkapintay. The Mascas were one of the groups that lived in the Paruro province about 30 km roughly south of Cusco, as recorded after the Spanish conquest (Bauer 1992:14–15). Furthermore, they were one of the mythological groups that took part in the founding of Cusco. In Sarmiento's version of the myth, the Masca *ayllu* was one of the ten *ayllus* who founded Cusco. For this purpose, Mascas were moved into Cusco by the eight mythical brothers and sisters who had emerged from a cave (Sarmiento 1988:51–53 [1572:Ch. 11]; Urbano 1981:66–68). Members of the Masca *ayllu* were still living in Cusco at the time when Sarmiento wrote. From the way in which Sarmiento refers to them, it can be inferred that the Masca *ayllu* formed part of *hurin* or Lower Cusco,

one of the two moities in Cusco, and lived in the Cayocache section (now called Belén). Max Uhle suggested the possibility that the first inkas were of Masca origin and that the Inka royal head-dress had its origin in Cuntisuyu, where the Mascas stemmed from (Uhle 1907:232). In inka society, the head-dress was called the *masca paicha*. There would, in that case, be a special connection between this group and the rulers of inka society. Regardless of whether Uhle's hypothesis is well founded, one possibility for the set of terraces at Ollantaytambo is that they were actually cultivated by members of the Mascas from Paruro or from Cusco.

Also the Tambos form part of the myth of the origin of the inkas. Again in Sarmiento's version, out of three openings (*tocco*) in a mountain came three groups: eight siblings out of Capac-tocco, the Maras out of Maras-tocco, and the Tampus out of Sutic-tocco. In Sarmiento's time, there were members of the Tampu group living in Cusco. Although Sarmiento is not quite clear on this point, it appears that also the Tambos were living in the Cayocache section of Cusco (Sarmiento 1988:52–53 [1572:Ch. 11]).

Both the Mascas and the Tambos of the Paruro province south of Cusco were inkas-by-privilege, as were the Chillque in the same province (Bauer 1992:15). Although Bauer considers that the Tambos of that region south of Cusco and the Tambos of Ollantaytambo belonged to two different ethnic groups, we should not exclude the possibility that they were related and that one might have been the offshoot of the other. What links them is not only their identical name but also the fact that both were inkas-by-privilege and therefore had a special status in the empire. If they were related, then one reason for them to stay in more than one place may have been that this enabled them to cultivate a larger variety of crops.

Functions of inka origin

We have documentary evidence of three individuals at Ollantaytambo who fulfilled specific functions of inka origin. Firstly, Juan Visa Condor, was a "principal" of the village and also a *khipukamayuq* in 1585. We can assume that he was a descendant from *khipukamayuqkuna*, since that occupation was hereditary (Rowe 1982:102). His name seems to indicate that he was considered a diviner and one with a priestly affiliation (Guaman Poma 1980:160, 304 [1615:183 [185], 330 [332]]; Santa Cruz Pachacuti (1992:201, 215, 258 [1615]).

Secondly, Diego Gualparimache, then an old man, was referred to as a *cacique* of *pachaca* in 1608 (Glave & Remy 1983:12, nn. 47 and 48, p. 39).[6] This composite term is usually translated as "a leader of a hundred families", *pachak* meaning one hundred in Quechua. In the inka empire, there were efforts to organize the population into a hierarchy based on

decimal units. In his analysis of the decimal system, Åke Wedin concluded that it was originally used to organize the army (1965:40–41). Julien, on the other hand, favours the idea that it was elaborated for labour recruitment and that service in the army formed part of that obligation to the state (1982:144–145, n. 4). To appoint leaders of a hundred households formed part of the system in which the lowest level was the grouping of five or ten households under one leader and the highest was the grouping of ten thousand households under one leader.

It should be noted that the term *pachaca* is also given other meanings. It is interesting to find that Guaman Poma uses the term *pachaca* for *labrador* (1980:165, 304 [1615:191 [193], 330 [332]]). In van de Guchte's study, this has been translated as "stone-carver" (1990:324). However, the Spanish term *labrador* literally means "worker" but stands for a "peasant", especially when an owner of land. The Quechua term *pachaca* indicates that, in this case, such a labourer was working the soil (rather than stone). *Pacha* furthermore means "soil, earth" (apart from its meanings of time and space). The additional meaning of *pachaca* should in this case therefore be "peasant".

González (1989:270 [1608]) gives another emphasis to the term in that he translates *pachaca* by "major mayordomo of the Inka who was in charge of his property"[7] and with "principal serf or brought-up over all the serfs and property and trustworthy. He who is in charge of, and he who guards all that his master has, or mayordomo or provider of supplies or procurator of the property".[8] Apart from the connection with property and with the Inka ruler, we find an interesting link with serfs or "brought-ups" in González Holguín's translation. He has no entry for *sieruo* (serf) but under the heading *criado* (brought-up), he uses the term *yana*.[9] With the meaning given by González Holguín, the *pachaca* was, then, a principal servant, a person in whom confidence was placed, who was in charge both of other servants on duty at the same lord's house and of that same lord's property, including the stored goods. The servants would, then, be the *yanakuna*.

Although this is hypothetical, we may have in Diego Gualparimache a mayordomo heading *yanakuna* of Ollantaytambo, *yanakuna* in part descendants of *yanakuna* who in former generations had served an Inka ruler or other representatives of the administration in Cusco. As far as we know, some officers inherited their positions in inka society, while other officers were appointed (Julien 1982:125). In the case of Diego Gualparimache, he may have inherited the title from his father, whom we know was in fact one of the leaders of Ollantaytambo (see below). The name Gualparimache is also informative, in that it indicates a function as an intermediary, a speaker, an interpreter and a solicitor for others (González 1989:174, 317–318 [1608]).

Thirdly, there is yet one interesting person mentioned in the documents, and that is Francisco Mayontopa. Glave & Remy believe that he was the local chief when the Spaniards came and is likely to have taken part in Manko Inka's revolt. Indeed, if there was a leader of the people living in and around Ollantaytambo, this implies some form of social, political and economic unity (Espinoza 1973:247). An interesting point here is that he was of Cusco descent. In one document, he is said to be a descendant of the Inka ruler Pachakuti Inka Yupanki, in another he is said to belong to the *panaca* or noble *ayllu* of the Inka ruler Tupa Inka Yupanki (Glave & Remy 1983:12, 39).[10] Both statements may be correct, since a descendant of one Inka ruler would automatically be related to any other Inka ruler, on account of their internal blood relationship. Again, then, we have an indication of a link between Ollantaytambo and the Cusco rulers. His name contains an honorary title, that of *tupa*, meaning "lord" (González 1989:347 [1608]). Although Francisco Mayontopa was a principal leader, he was not the only one but had a joint leadership with Gonzalo Cusirimache. We know that Gonzalo Cusirimache was born around 1524 and would thus have been a child when the Spaniards came and when Manko Inka revolted (Glave & Remy 1983:12–13).[11]

Evaluation

The panorama that emerges is that of a very mixed population and of links between Ollantaytambo and many other areas. All in all, we have vestiges of connections with or the presence of about a dozen groups. Some of the connections most probably go back beyond the time when Ollantaytambo was incorporated into the inka realm.

We must also take into consideration that some of the groups that lived close to Ollantaytambo and worked lands there in late inka times did so not by command of a state authority but to cultivate crops that could not be grown in their homeland. Those groups did not necessarily take part in the cultivation of the state lands (Espinoza 1973:243). The exploitation of different ecological zones by members of a single group is a well-known phenomenon among students of the Andean cultural traditions, from prehistory and into our own times. In the valleys of Pachachaca and Abancay in inka times, groups from higher altitudes cultivated the warm valleys (Espinoza 1973:239). The Lupaqa kingdom of the fifteenth and sixteenth century in the Lake Titikaka basin apparently had colonies both on the Pacific coast and in the semi-tropical valleys on the eastern edge of the Andean mountains, as did the Tiwanaku polity a thousand years before that and onwards (Kolata 1993:27, 250). Some of the groups of whom we find traces at Ollantaytambo may very well have had lands there already in pre-inka times.

In the case of Ollantaytambo, as published by Glave & Remy, we have but one group that is explicitly called *mitmaqkuna*, namely the Qollas. Only in the case in which a group is called *mitmaqkuna* can we presume that their members were actually resettled and were not present in a certain area only to perform specific tasks and then were to return to their homelands after the work had been accomplished. However, as noted in section 1.2 on "Previous research and present state of knowledge", the difference between *mit'a* taxpayers and *mitmaqkuna* cannot always be undisputably distinguished on the basis of the written sources. The Qollas at Ollantaytambo are not said to be associated with stonework but worked the lands of Collcabamba, as noted earlier. This can be taken to signify that they worked the agricultural terrace from which produce was taken to be placed in the state storehouses (*qolqas*). Even work carried out by the *mitmaqkuna*—and not only work usually thought of as accomplished by *mit'a* labour—could be rotational, in that they could work the state lands by turns (Espinoza 1973:240). Therefore, the Qolla *mitmaqkuna* at Ollantaytambo did not necessarily work the lands of Collcabamba continuously. The *mitmaqkuna* of other groups may have had their turns on the same lands before 1555, while the Qollas were involved in other tasks, including stonework. Other groups at Ollantaytambo, such as the Chachapoyas and Ami Yungas, were probably *mitmaqkuna* as well.

Unfortunately, I have not been able to trace any published documents whatsoever on any local *ayllus* that could have been engaged in the stonework as *mit'a* labourers. It is particularly interesting that no locally originated *ayllus* at all can be clearly distinguished in the documents dating from the time of the Toledan *visita*. Did they live far away enough from the settlement not to be included in the record or were they simply not present? The trapezoidal settlement was certainly constructed by order. With a construction initiated by outside forces, such as by one of the Inka rulers, no local group was needed or maybe even wanted within its confines. There is a possibility that the local population was re-organized after its incorporation into the growing empire, in order to fit into a preconceived plan, a plan that was a copy of or similar to that of Cusco, the capital. Then the hypothetical existence of a *hurinsaya* outside the trapezoidal settlement named Tambo after the local population is reasonable. It is also possible that most of the local population had been moved from Ollantaytambo to other parts of the empire as *mitmaqkuna* before—or in connection with—the building of the fancy agricultural terraces, including those between the Vilcanota River and the settlement, the construction of the trapezoidal settlement, etc. In the valleys of Pachachaca and Abancay, the greater part of the valuable lands by the rivers were converted into *moyas* or state lands, worked by people (*mitmaqkuna*) brought in from other provinces, while the major part of the local population was

in turn moved to other regions of the empire (Espinoza 1973:230). A similar fate, although by no means identical, could have met any pre-inka inhabitants of Ollantaytambo as well as its surroundings. If this was so, then the descendants of the inhabitants living in the area before the inka take-over are today to be found in another place or places. This could also, in part, explain, why so little is heard in Ollantaytambo today about how the stonework was executed. If the local population was moved away from Ollantaytambo before the stonework started and if they returned only after the work had ceased for good, then we cannot expect any concrete information from their descendants.

In the case of the valleys of Pachachaca and Abancay, it appears that actually most lands were turned into *moyas* or state lands after the inkas conquered the region, while only a few fields were reserved for the *mitmaqkuna* who were brought in to work the state lands and to live there (Espinoza 1973:230). The fields on which the *mitmaqkuna* maintained themselves were set apart from the fields which were used for state purposes (Espinoza 1973:231). If there was a similar pattern at Ollantaytambo, then the *mitmaqkuna* had their own—own in the sense of usufruct only—plots of land to sustain themselves. They would have been located away from the valley floor, on the mountain slopes above the valley (Espinoza 1973:242). This phenomenon also compares well with what is known about the Yucay Valley (Villanueva 1970*a*).

We know that groups could be sent from different parts of the empire to work on construction. It appears that a region could continuously have a certain number of taxpayers engaged in such work, although the same individuals were not stationed there but were exchanged on a rotational basis. The groups engaged in the stonework at Ollantaytambo are not necessarily identifiable in the records. We do not know for certain by what term any such group would be called in its new setting, that is, whether it was called by its *ayllu* name or names, the *suyu* or part of the empire from which it came, the administrative centre that sent it, or by some other name. It is at least highly probable that it would retain a name, local or regional, from its homeland.

Garcilaso states that people with the surnames Urcos, Yúcay and Tampu lived in what should be understood as the Vilcanota Valley. Although he is somewhat unspecific about indicating where, in my interpretation, they lived down the river from Yucay.[12] This also corresponds to where the settlement of Ollantaytambo is located. They had pierced ear-lobes and wore large ear-plugs, a sign of high status in inka society (Garcilaso *c.* 1980:1:62 [1609:Bk. 1, Ch. 23]). Garcilaso provides this piece of information when he speaks about Manko Qhapaq's reign at the dawn of the inka state (see Table 1 in the "Introduction"). Unfortunately, the information as such does not provide any evidence for the

situation at Ollantaytambo that can be related to the stonework that interests us.

I tend to believe, although to my knowledge there is no direct evidence, that people sent to construct walls in Cusco could be re-assigned from there to work outside the capital itself, including the Vilcanota Valley (also see section 1.2 on "Previous research and present state of knowledge"). Any such re-assignment might not show in the records on *khipus*, such as those from the Lupaqa province or the Huallaga Valley. This would at the same time explain why Cusco was the only settlement specifically mentioned for such construction work.

From the scanty information we have, I propose that most of the stoneworkers and their descendants had actually left Ollantaytambo by the time the inhabitants appear in the historical records. It seems reasonable to think that most of the stoneworkers were not at home at Ollantaytambo. Either they left several times or they left only once, when the work ceased for good. If they left several times, that seems to imply *mit'a* engagement, in which case the workers after doing their turn went back to their duties at home, such as sowing and harvesting. If the whole crew left Ollantaytambo only once, they might have been either *mit'a* workers or *mitmaqkuna*. The descendants of the stoneworkers might be found today in the same major valley, that is, the Vilcanota Valley, or in distant places, such as the Huallaga Valley, the Lake Titikaka basin or the Chachapoyas province. Some of them may have joined the Spaniards and worked for them in Cusco and elsewhere, including construction work.

The stonework at Ollantaytambo must have involved a considerable number of workers, and the house remains that were apparently in use in inka times and that can be seen in the vicinity today are, in my view, far from enough to house that labour force. One reason may have been that the fancy terraces were constructed after the time when the stonework ceased. If that was so, any settlements in those sectors may have been obliterated. Another reason may be that many of the workers lived in tents and simple huts. That being the case, it is difficult to find vestiges of them in our archaeological surveys. This would explain the lack of large sites with house remains in the vicinity of the Kachiqhata quarries, as well as on the valley floor. This, again, favours the idea that the workers were mainly brought in from elsewhere and left Ollantaytambo when the work finally ceased.

[1] Both Yucay and Ollantaytambo form part of the same major valley, today often referred to as the Vilcanota or Urubamba valley. It can be deduced from the documents and chronicles that Yucay and Ollantaytambo were referred to by separate valley names (Garcilaso c. 1980:2:108 [1609:Bk 5, Ch. 27]); Villanueva 1970*a*:1). The same is true for Calca and Lamay in the same major valley (Albornoz 1989:180 [1583/1584]).

[2] Originally from the Archivo General de la Nación (Lima), Derecho Indígena. Drawer 614, folio 23. With 44 folios. "Autos que siguió Juan de Arrendolaza en nombre del Convento y Frailes de Nuestra Señora de la Merced de la imperial ciudad del Cusco, contra don Francisco Mayontopa, cacique principal del repartimiento de Collatambo", 1559.

[3] Protzen was given this piece of information by John Rowe. According to Protzen, originally from the National Archive of Peru, Lima; Derecho Indígena y Encomiendas. Folio 26v., bundle 31 (supplement), drawer 614, 1559–1560. The document forms part of "Autos que sig[u]ió Don Francisco Mayon Topa cacique principal del repartimiento de Tambo contra los frailes del convento de la Merced de la ciudad del Cuzco sobre posesión de las tierras de Colcabamba, 1555–1560."

[4] Originally from a personal archive of Pedro Terry García.

[5] The toponyms of terraces mentioned in Glave & Remy (1983) are originally from documents of 1595 and 1628 in the Biblioteca Nacional (Lima), Sala de Investigaciones, Manuscritos. B 1030. This set of documents consists of 286 folios: "Expediente sobre la petición presentada por el Licenciado Luis Enríquez, para que no se adjudiquen más tierras a Pedro de Soria" (1629).

[6] Originally from the Biblioteca Nacional (Lima), Sala de Investigaciones, Manuscritos. A 300, f. 196r (for Juan Visa Condor) and from the Archivo General de la Nación, Juicios de Residencia. Leg. 20, C. 51, f. 70v. (for Diego Gualparimache).

[7] Mayordomo mayor del Inca que tenia a cargo sus haziendas.

[8] Sieruo o criado principal sobre todos los sieruos y haziendas y de confiança. El que a su cargo tiene, y el que guarda todo lo que tiene su amo, o mayordomo o despensero, o procurador de la hazienda.

[9] Criado. Yana huc yana cuna, vno de los criados (González 1989:465 [1608]).

[10] Originally from the Archivo Histórico de Cusco, Archivo de la Beneficiencia Pública, Bec. 7 (for Pachakuti Inka Yupanki) and the Archivo General de la Nación, Derecho Indígena, C. 614 (for Tupa Inka Yupanki).

[11] It was Gonzalo Cusirimache s son, Diego Gualparimache, who was referred to as a leader of *pachaca* (see above).

[12] "... el río abajo de Yucay,..." (Quotation, Garcilaso c. 1980:1:62 [1609:Bk. 1, Ch. 23]). Cf. Bauer's interpretation (1992:30).

3.4 Labour organization for the stonework at Ollantaytambo: The archaeological evidence

During fieldwork, I made inferences about the labour organization for the stonework on the basis of the physical evidence. Although the inferences are fragmentary, I am confident that this is a fruitful way to use archaeology in studies of inka society. It is my hope that my interpretations will inspire other researchers to continue along similar lines and to go further than I have been able to do in this study.

Vertically

A great number of prepared blocks, both large and small, were left on the ground in the quarries, as well as along the transportation route and at the building site. If we assume that they were all destined for the temple area at Ollantaytambo, this assumption has quite a serious consequence; there was not room enough for all these blocks in the temple area. The space in front of the temple with more or less level ground measures only about 25×18 m. It can be argued that obviously the builders had another site—or even sites—in mind, where the majority of the blocks were to be placed. A complicating factor is that we do not have any clear evidence of any such other site. My own interpretation, although admittedly a questionable one, is that the blocks were extracted and prepared in the quarries, while their exact use was not yet defined. The same would be true for blocks in the storage spaces in and close to the rock-slide areas. It would even be true for the blocks along the transportation route, including those that had already reached the valley floor. I am suggesting that only one construction site was defined, the temple area. I base this suggestion on field evidence. We have evidence for the use of blocks from the quarries of Kachiqhata in the temple area. On the other hand, there is a lack of any consistent evidence for the use of such blocks in other parts of Ollantaytambo or elsewhere. To explain the presence of the great number of blocks—several hundreds—that were left in different stages of preparation, I argue that this can best be done by viewing the blocks as the result of the organization of labour. Each phase of the stonework was thus organized separately. With this model, the extraction of material was organized apart from the actual construction. The different phases were not co-ordinated. This means that the amount of construction material extracted from the quarries was not calculated to meet the needs in the temple area. This points to a vertical organization of labour. For example, one person—or a pair of leaders, a type of leadership common in

the central Andes—might have been in charge of the work in the quarries, another of the transportation, and a third of the construction. These leaders did not co-ordinate the efforts made in the different sectors. Instead, each sought to fulfil any demands made on them from higher levels in society. The leaders at those higher levels to some extent gave instructions at least about the end product wanted, but they did not inspect all the sectors where work was being carried out and therefore did not correct any discrepancies between supply and demand. One possible outcome of such a system is, of course, that there will be either a shortage of blocks ready to be transported or a surplus. The same could then easily occur at the construction site: the builders might have to wait around for the material to arrive at the spot or in other instances they might have the problem of having to move over and in between building material that had arrived too early. Such logistic problems would be even more apparent, if the workers did not move between different tasks and different sectors but were rather bound to one single task or were placed to work in one single sector.

Horizontality

There are sometimes different types of preparation marks on one and the same block. For example, one side may show rounded marks, while another has vertical furrows. My interpretation of this phenomenon is that different individuals worked on different sides of the block. It seems, then, that the individual labourers working at the same level in the organization had some freedom to choose between different body movements, although all the preparation was performed to fit within a certain tradition.

Task groups

There are signs in the quarries that indicate that specific groups of workers were formed and that they did not interfere with each other's activities. One such example is a spot high in the southern rock-slide area, where there is a large block left during preparation (Figure 75). The upper end of a ramp is close by, a ramp that leads obliquely down the mountainside. The peculiar thing about this spot is that there is no connecting point between the block and the ramp. One would expect to find the ramp leading from the actual platform on which the block lies. Instead, there are a number of boulders between the ramp's upper end and that block. There is no trace of an empty platform for a block already moved away, where the ramp starts. That would otherwise have explained the ramp's starting-point. My interpretation of this phenomenon is that those who prepared the blocks were not the same as those who built the

Figure 75.
The preparation of the lower parts of a block-side had to be done kneeling. The lowermost part of this block was left to the last, and a shelf was thus formed. Block no. 107, the southern rock-slide area. Facing SSE.

ramps. In this case, two groups could very well have worked independently of one another. There is no problem of space or otherwise for two groups to work. With two groups working, it was not necessary to build the ramp first and then to prepare the block chosen or the other way round for that matter. There are similar examples in both the western and the northern rock-slide areas. It seems reasonable to believe that the preparation of blocks and the building of ramps took place simultaneously and were done by different groups. I am suggesting that these groups were quite well-defined, task groups. This does not exclude the possibility that a task group could change tasks within certain limits, if need arose.

Possibly there were more task groups working in the rock-slide areas. For example, people building platforms were maybe not the same as those who prepared blocks or built ramps.

Another task group could be formed by the people who supplied the material for the ramps. Most of the material for the construction of ramps was available on the spot or close by, but stones and boulders of suitable sizes had to be chosen; sometimes they were also cut to size. Soil was also moved and worked before it was employed in the ramp construction.

In addition, there are vestiges which indicate that different groups were in charge of different sections of the ramps. The clearest example that I have observed is the temple ramp, where the wall was built in segments. Where different segments meet, the stones do not bond, and the wall shows an almost vertical fissure. The construction itself differs somewhat as between the segments. I have noted that on one side of a fissure,

the stones are roughly cut and set in only a little mortar; on the other side, the stones are natural in shape and set in a larger amount of mortar.

A division of the workers who built the ramps into groups would, at least in part, explain the different ways to stabilize a wall. I refer to the construction with either an even inclination or a ledge or ledges in the wall. Both ways can be seen in the ramps of the rock-slide areas, as well as in the temple-ramp wall. Other groups may have been in charge of the transportation of blocks or of the provision of food and drink.

Tools had to be provided for the masons. The evidence we have so far shows that stones from the actual rock-slides and water-rolled cobbles were used for the stonework. The water-rolled cobbles were not available, either at hand in the quarries or at the building site. Instead, they were quite certainly brought from the Vilcanota River. We do not know whether the masons who worked in the quarries stayed overnight on the Kachiqhata slope or whether they moved back and forth between the valley and the quarries each day. If they stayed in the quarries or close by, others had to bring them the tools. Possibly a special group of people had that responsibility. If the masons descended to the valley floor every afternoon, each mason might have been in charge of his or her own tools and therefore searched the river shore or river bottom, whenever new tools were needed. This may even been done every afternoon after work. One explanation of the few tools left behind in the rock-slide areas may actually be that the hammerstones that stemmed from river cobbles were offered to the river when worn out.

Since the river cobbles were quite ready as tools when they were found, the task of searching for them could, as an alternative hypothesis, have been carried out by children and adolescents. The sizes and rock types needed could easily be taught to unskilled labour. Those who provided the cobbles might have formed a task group, but, given the ease with which such cobbles could be picked without any major organization, this was probably not necessary. It is worth mentioning here the place between the railway station and the island in the river that is at the height of the Rumira fields, where a former course of the river has left an area with large amounts of river cobbles exposed and with only a little soil (also see section 2.3 on "Rough preparation" for this spot). It is a place where cobbles could be chosen and collected without any constraints due to the river current.

It seems that different task groups were acting in the temple area as well. It is clear that the blocks were not transported to the building site and then placed in a wall one by one, so to speak. On the contrary, some were left on the ground, and others were placed on narrow platforms, while others again were placed in a wall. Not only had blocks to be moved around in the temple area, but the platforms had to be built and

the blocks had to be finely prepared and fitted. Some of the blocks were re-arranged even after having been placed in a wall.

Intensity and Flow

As mentioned, there are prepared blocks in all the three rock-slide areas, all along the transportation route, and at the building site. This indicates a constant flow and provision of building material. The work was so organized that all the types of work required for the construction were carried out simultaneously. There were people working in the quarries, along the transportation route, and at the building site at the same time. Moreover, a great number of blocks were apparently being prepared simultaneously in the rock-slide areas. This indicates that the labour was intense in character and probably involved quite a large number of people.

Sequencing

What has been said above about intensity and flow can be related to another phenomenon, namely that of the sequencing of the labour process. In some sectors, blocks lie in a row, in others they form agglomerations, and in yet others their location shows no clear patterning at all.

The pattern of forming a row is clearest along the main transportation trail, where there are blocks lying one by one at some distance from each other. Another spot is on the valley floor, where we placed our test-point 1 (Figure 46).

As to agglomerations, there are several of them. It would seem that there were stations for blocks on their way as natural boulders in the actual rock-slides to their final placement as finished blocks in a wall. Firstly, there are the workshops, such as that at our test-point 6 in the western rock-slide area (Figure 21). A few other spots not illustrated here can be included in that same group. Secondly, there are the places which I have called "storage spaces", at least one of which also served as a workshop. That one is on the lower margin of the western rock-slide area (Figure 30), another is on the eastern edge of the southern rock-slide area, and yet another is at Nawinpata, close by the main transportation trail (Protzen 1985:164, 1993:147). Thirdly, there is an agglomeration, and quite an interesting one, on the valley floor, in and near the Rumira fields, and our test-point 2 forms part of it (Figures 8 and 47).

The places where no internal pattern in the placement of blocks can be discerned are especially notable in the actual rock-slides. Anyhow, a certain degree of sequencing was necessary, in that a boulder lying in the actual rock-slide at some point had to be moved somewhat, to make enough room to prepare it. The preparation that was done at this stage

only went so far; after that, the block was moved out of the actual rock-slide.

My interpretation is that the blocks lying in a row represent a simultaneous transportation of blocks. On a trail or ramp, there was not room enough to move large blocks side by side. One group of people was in charge of each block being moved, and space had to be left in front of, as well as beside and behind, each block to allow the transporters to start and keep the block moving, to move about themselves and to control the block's course. Therefore, a certain space was preferably left between the blocks.

The blocks forming agglomerations I interpret as representing a stoppage in the transportation. This may have been due either to the need for further preparation of the blocks, or to a lack of space to continue the transportation, or both. The need to continue the preparation of the blocks can be exemplified by the workshops, such as that at test-point 6 in the western rock-slide area, and by the storage spaces/workshops, such as that at test-point 5 on the lower edge of the western rock-slide area. The need to await a larger space for the workers to move around in can be exemplified by the agglomeration in the Rumira fields, whence the blocks were to be moved up the narrow temple ramp. With this interpretation, the agglomeration of blocks in the inner temple area represents the need both to give the blocks their final touch and to await the necessary space to move them around and place them in a wall.

I took into consideration the possibility that blocks were continuously worked during the transportation, but the field data do not support such a procedure. Blocks closer to the building site are not consistently better prepared than blocks closer to the areas of extraction. Another observation is that neither flakes nor stone powder of prepared blocks of the Allinyana granite were found along the route, with the exception of flakes at one spot mentioned in section 2.4 on "Transportation", namely below the north-western chute down the mountainside to the valley floor on the Kachiqhata side of the river.

There is a pattern, although not a consistent one, in the order in which different block-sides were prepared. The masons tended to prepare the long sides of the large blocks before they prepared or finished the short sides. Such blocks were banked a quarter of a turn or half a turn during the preparation. The grounds for the argument are that in some cases the preparation marks go sideways on the sides turned; in other cases, the empty space whence the block was banked is clearly distinguishable. In a couple of instances, a boulder which might have served to lift the block from the ground to facilitate the banking is still in place.

The ground was not always cleared by a block, before it was prepared. I have seen blocks with preparation marks still lying among the boulders

from a rock-slide, sometimes with only one end sticking out. Consequently, the workers could start to prepare a block before the ground was levelled. Some of the boulders would at a later stage unavoidably have had to be moved to gain access to the rest of the block.

Time of the year

The stonework was most probably done in only part of the year. During the rainy season, there are powerful thunderstorms in the mountains around Ollantaytambo, including the Allinyana mountain, near which the quarries are located. In the dry season, on the other hand, the weather conditions are much more favourable. The effects of the strong sunlight can be offset by wearing a hat and by taking in liquid.

Not only in and by the quarries was it much easier and less risky to work in the dry season. During the transportation of blocks, the Vilcanota River had to be crossed. This was best done in the dry season, when the current was comparatively slow. Furthermore, the river is only about half as deep in the dry months of July, August and September as it is in the rainy months of January and February (Gade 1975:6). In addition, the waters are quite clear in the dry season and that must have been an advantage if, as I have suggested, the blocks were transported through the water.

It is possible that the stonework was carried out during successive years and that the work ceased each year when the rains started. With this interpretation, the abandonment of the project that we see vestiges of today was only the last one in what was actually a series of abandonments, and one that was only meant to be temporary.

If the blocks were transported through the fields, as seems to have been the case, it was probably highly desirable to avoid destruction of the crops. Each block in itself did not occupy very much land over its trajectory, but the work force probably did. I doubt that all the blocks on the valley floor were moved simultaneously but am at the same time convinced of the intense character and large scale of the labour. For the sake of argument, we can assume that three work groups were engaged simultaneously for the transportation on the Ollantaytambo side of the valley floor and that each transport worker was in charge of 100 kg of rock mass. If one group moved block no. 22, which lies by the railway, another group moved the block at test-point 1*a*, and the third group moved block no. 48 at test-point 2, then the total number of transport workers treading the fields would be about seven hundred.[1] I find it highly unlikely that the transportation took place during the growing season.

If we look at the agricultural cycle near Ollantaytambo today, the fields on the valley floor are especially suitable for maize cultivation. The maize is harvested in May and sown again in September or, less com-

monly, in July or August (Gade 1975:122–124). The chronicler Guaman Poma wrote that May was a month of harvest and that the sowing of maize started in August and continued until January, depending on the climatic conditions of the region (Guaman Poma 1980:219, 225 [1615:245 [247], 251 [253]]). We can infer that a good time for the transportation of building blocks on the valley floor would have been in June, July and possibly August, that is, in the dry season. The maize harvest was over, and the season for sowing again had not yet started. The transportation would thus not have damaged any sowings. If peasants participated in the stonework, the dry season would certainly have been a good time of the year for them to do so.

Living quarters and accommodations for the dead

There are no visible remains of major installations on the Kachiqhata slope or nearby to house large groups of stoneworkers. In the actual rock-slides, I have noted only the remains of a single house. It is a one-room structure with stones and boulders from the rock-slide placed horizontally to form the walls. No mortar was used, and the structure is severely damaged. The house is rectangular in shape and measures 6×4 m. In part, it stands on a huge boulder from the rock-slide. It stands at the junction of two short ramps in the western rock-slide area. Its location allowed for a good overview and suggests that it was indeed closely related to the stonework. It may have housed one or several supervisors. Another possibility would be that it was used as a shelter from the weather for some of the stoneworkers.

On the other hand, there are several small groups of remains to the north-west, north and north-east of the rock-slide areas, on the Kachiqhata slope. One of the sites is in a sector called Paqpayoq, between the rock-slide areas and the valley floor. It contains about forty houses. Of the surface ceramics we collected at the site, the majority were defined as inka or classical inka by Lunt. Some were from vessels in circulation by the Late Intermediate Period. A larger proportion of the sherds than from our other sites were unknown to Lunt. Maybe these pots came from some other region? The architecture has inka features, but they are not systematically applied. The location of the site makes it a good candidate for a settlement for stoneworkers, and the ceramics suggest that it was inhabited at that time. It may have housed part of the population of Ollantaytambo in inka times, that is, before the inhabitants of the area were "reduced" to one settlement in the 1570's.

Another site is below the Kachiqhata mountainside by the Vilcanota River, on the valley floor between Puntapampa and Choquekillka. The structures there are round, either storehouses or living quarters. The buildings are badly eroded and only the lowermost sections of the walls

still stand. The surface ceramics analysed by Lunt included sherds whose closest style was Cusco/classical inka, and Late Intermediate Period sherds whose closest style was Killke/Killke-related. It is a site, then, which was apparently in use at the time of the stonework and which may therefore be related to it. There are no indications in the ceramics of a strong presence of people from outside the Cusco region.

We have not had any ceramics analysed from the other sites on the Kachiqhata side of the Vilcanota River. Judging by the architecture, there are sites with house remains dating from inka times, so there is a high degree of probability that they were in use when the stonework was executed. Possibly, any remaining inhabitants were moved into the settlement of Ollantaytambo in the 1570's.

There are graves on Kachiqhata of other types than the grave-houses dealt with in section 3.1 on "Time span". One mode of burial was to place the body of the deceased beneath a natural boulder, sometimes with a simple wall on one or two sides marking the grave's limits. Two sherds from one such grave in the Mollepuqro sector were classified by Lunt. One had a pre-inka design and finish but was made by inka technique; the other was a Cusco/classical inka sherd, possibly from an aryballus. On top of the very same boulder stands a grave-house. With the little evidence we have, it seems, then, that the burials under boulders were in use at the time of the stonework. Further up the slope, in a precipitous sector, there is yet another kind of burial in sight, with contiguous burial structures plastered with yellow clay facing the valley. We did not investigate these but they may by comparison very well be from inka times. Maybe the different ways of depositing the dead are the expression of groups of different social or geographical origin, but I lack data to support such a statement on archaeological grounds.

If we look at the ceramic evidence from our investigations, most of the sherds come from vessels probably manufactured in the Cusco region. On the one hand, that could mean that the stoneworkers and others present were from the Cusco region as well. On the other hand, *mit'a* labourers are said to have been provided with food from the state supplies, so it is possible that the sherds tell us more about the vessels in the state storehouses than about the people using them.

Even if the stoneworkers stayed overnight close to the rock-slide areas, they did not necessarily live there. They might have slept in tents or simple huts. If they lived on the valley floor, they could walk back and forth each day. A young person well adapted to the altitude, who walks from the Ollantaytambo settlement with a fast and springy gait and does not carry a load, reaches the nearest side of the northern rock-slide area in three-quarters of an hour. To the upper and far side of the western rock-slide area, it takes about an hour and a half from the settlement. Walking back takes roughly half the time. If the stonework was only car-

ried on for part of the year, as indeed seems to have been the case, then it is probable that most of the workers had their proper homes away from the quarries themselves. Although it is not likely that they lived in the settlement itself, they could very well have lived at locations as far away.

[1] The basic data for the calculation are as follows. Block no. 22: length 7.16 m×breadth 2.18 m× height 0.8–0.9 m×density 2.7. Block at test-point 1*a*: length 2.28 m×breadth 0.35×1.00 m× height 0.75–0.80 m×density 2.7. Block 48 at test-point 2: length 6.7–7.2 m×breadth 1.6–1.7 m× height 0.7–1.3 m×density 2.7.

3.5 Labour security and health care

All monotonous work is harmful to the health. Stonework includes repetitive body movements. To minimize long-term wear and tear on the body, the work posture must therefore be carefully thought out. It is also important to use tools that fit the size of the body and the hand. When transporting heavy material, it is crucial to avoid sudden tugs or jerks. Other factors that influence the health include the length of the working day, shelter against wind, rain and excessive heat or cold, the quality and amount of food, facilities for rest and sleep, and social intercourse.

When hammering a block, flakes and chips bounce off the surface. Without goggles, such material can seriously damage the eyes and also harm other parts of the body, such as the face and hands. The danger is greater when working with fine-grained stone, such as flint, because the flakes will have sharper edges. It is nevertheless also a problem when working with granite.

Another risk is that of stone dust, as inhaling air containing such dust over an extended period of time harms the lungs. In the Swedish granite industry between the mid 19th and the mid 20th centuries, many masons contracted silicosis and died of it. The risk was considerably greater when working indoors, as compared with out of doors. When working out of doors, on the other hand, rheumatism and problems with the windpipe were more common. Other diseases and disorders that were common among the Swedish masons involved back pain, sciatica and headache. Bone would form in the hands, owing to the efforts made and the vibrations, and that sometimes caused aching. Chronic "crunching" in arms and wrists was also common. The most frequent casualties in the quarries were due to workers getting into a "squeeze" or having their teeth knocked out (Bohusläns ... 1979:24–25; Rehnberg 1973:26–27). It seems probable that the health of the stoneworkers in Ollantaytambo in inka times was affected in a similar way, possibly with the exception of rheumatism and windpipe problems, as the climatic conditions are more extreme in Sweden.

We have very little information as to the extent to which specific arrangements were made to secure the well-being and health of the workers or to prevent casualties in work situations in inka society. As regards any reference to stonework in the written sources, to my knowledge only one specific event is reported. In Garcilaso's version, a very heavy boulder was being moved towards Saqsaywaman near Cusco. In its movement downhill, the block went out of control and continued on its own course. It was being moved by more than twenty thousand people, and during the incident three or four thousand people were killed (Garcilaso *c.* 1980:3:75 [1609:Bk. 7, Ch. 29]). In another version, the boulder fell

three times during its transportation, and some people got killed (Cobo 1990:56 [1653:Bk. 13, Ch. 13]). In Murúa's account, nothing is said of any people getting killed, but close to Saqsaywaman the people involved in moving the boulder killed the captain, Inga Urcon, who had ordered its transportation (Murúa 1964:2:6 [c. 161 l:Vol. 2, Ch. 87]). In yet another version, the transporters failed to move the boulder into place because of lack of space to pull it, and they therefore fled to their homes (Gutiérrez de Santa Clara 1963:252 [1595–1603:Bk. 3, Ch. 63]). If the story has any historical truth in it, it would certainly be a rare case, in which the people reacted strongly as a result of unacceptable working conditions.

As far as Ollantaytambo is concerned, I have been able to note some evidence and clues to the working conditions. Some measures of care were taken by or for the workers. At the same time, not all the possible measures were taken.

There are vestiges of installations that improved an otherwise uncomfortable working posture. A workshop terrace, platforms and flattened spaces similar to the platforms were constructed to provide level ground (Figures 16, 20 and 21). Stones were sometimes piled under the edge of a block to lift it from the ground and make it lie horizontally (Figure 25). Scaffolds of stone near some blocks made it easier to climb on them and to prepare parts otherwise difficult to reach (Figure 24).

The main transportation trail and usually also the ramps were given an even inclination (Figure 38). That must have made both the descent and the ascent much easier to control and therefore safer.

Ramps, as well as the main transportation trail, had their walls constructed so that they leaned inwards (Figures 39, 40 and 41). That prevented them from collapsing on account of the friction and the heavy weights of blocks and the people on top of them or on account of erosion. Also the temple itself was constructed with an inclination inwards, most probably to stabilize the construction (Figure 4).

The easiest surface to prepare on a block was the upper surface, since the easiest way to handle a tool like a hammerstone is with a downward motion. We may compare this with experiments carried out with heavy axes used on wood. The workman got a sore and stiff wrist when he used the axe on a standing tree but not so when he used it on a horizontal log. When used on a horizontal log, the axe fell more on account of its own weight and thus required less force (Olausson 1983:96–97). If it was in the interest of those in charge of the stonework to keep their workers able, then smaller hammerstones would be used for the block-sides, while larger ones could be used for the upper surfaces of blocks.

The preparation of the sides of large blocks was normally performed with the mason's back in a roughly vertical position. For large blocks, this could often be done standing up (Figure 17). In some phases, the

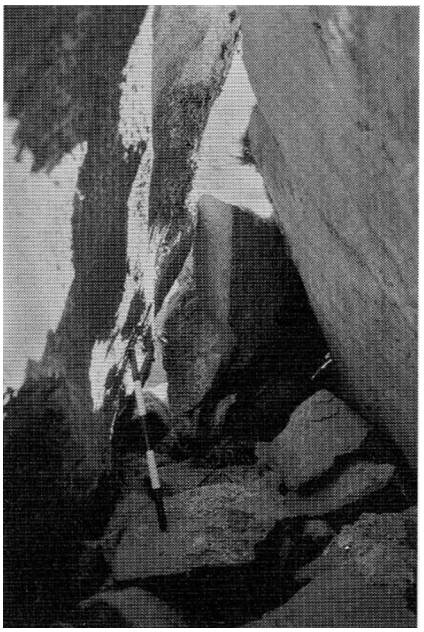


Figure 76.
The working space between block and boulder is very narrow. Block no. 102 is to the left in the photograph. To the right is a huge boulder. The southern rock-slide area.

preparation had to be done kneeling, for example, while preparing the lower parts of the sides of large blocks or while preparing small blocks (Figure 75). Sometimes the kneeling had to be combined with leaning forward, for example, when preparing the upper part of a high block-side while sitting on the upper surface of the same block. Other phases of the preparation were, in all probability, performed lying down. Sometimes this had to be done with the arm and hand at an awkward angle. The working space between block and boulder (Figure 76) or between block and ground was in some cases very narrow, and the mason had to crawl to get access to the surface to be prepared.

As regarded bouncing flakes, chips and stone dust, there were cases in which the mason lay underneath the surface to be prepared. This was a kind of preparation that could be performed by unskilled labour. Working lying down, with the dust penetrating any piece of cloth worn for some protection of the lungs and with flakes and chips bouncing into the mason's face, including the eyes, was certainly particularly harmful. I would go so far as to say that an unskilled mason's life was maybe not worth very much.

Other risks can be inferred from factors such as the weather conditions and the kind of building material. To work out of doors during the rainy season at Kachiqhata is hazardous, especially during the middle of the season. The thunderstorms in the heights are complex, with intense lightning. The rains can be quite heavy. We do not know whether the masons worked at Kachiqhata during the rainy season and out of doors. So far, we have no indications of shelters used during the preparation of the blocks. This is not to say that they did not exist. Anyhow, for the extraction and transportation of blocks, shelters would be of little help, since the workers had to move around. If any work was done during the rainy season, the weather certainly constituted a peril, especially due to the lightning.

As mentioned earlier, the talus cones of Kachiqhata did not form during a single moment (see section 1.3 on "Ollantaytambo and the investigation area" and Ahlgren in the Appendix). They were built up over an extended period of time and do so to this day. Boulders and stones come loose from the almost vertical surface of the Allinyana mountain above. They fall freely until they hit the slope, and then bump and fly downwards until they settle. This is not a phenomenon that occurs every day, but it is common enough to have constituted a risk for the workers. Most of the falls that I heard occurred during the dry season. The sharp contrast between day and night temperatures at that time of the year is probably the major factor that produces the cracking of the fissures in the rock.

Stone is a heavy material. According to simple density measurements, a block from Kachiqhata measuring one cubic metre weighs 2,550–2,780 kg. This fact must have constituted a clear risk factor in a work situation. When banking or moving a block during its extraction or along the transportation route, and when placing the block in a wall, its mass and moving force had to be very carefully controlled. There were especially crucial moments, for example, when the transporters initiated the movement of a large block or when it was tipped over the verge at the end of a ramp or trail and into a chute. Apart from that, there was always a danger that workers would fall over the edge of the wall on the lower side of the narrow ramps or trails and down the mountainside. This would sometimes mean a fall of several metres. If blocks were taken through the Vilcanota River, the current had to be taken into account. Collapsing ramp walls or badly placed blocks in the construction had to be prevented. If enough attention was not given to security, the workers could be severely injured or even killed.

3.6 Motives

Polo was impressed by the inka constructions and wrote that many, it seemed, had looked for opportunities to make edifices without any purpose (1916*b*: 108 [1571]). Garcilaso said that the Inka ruler Inka Viracocha had constructions built in the valley of Yucay and further down, in Tambo (Ollantaytambo), some of which were for recreation and others to show his majesty and greatness (*c.* 1980:2:109 [1609:Bk. 5, Ch. 27]). The buildings that Garcilaso referred to most likely included those made of fine masonry.

Stone was in many ways sacred to the inkas. They venerated high mountains, and they considered rocks to be the places of origin of groups of human beings. People were believed to have been transformed into stone in remote times (Molina 1989:51–53 [1573]; Sarmiento 1988:40 [1572:Ch. 6]), and stones had also become alive (Santa Cruz Pachacuti 1992:220 [1615]). Peculiar stones were—and still are—kept in the homes and elsewhere (Arriaga 1968:28–30 [1621:Ch. 2]; own observation, 1989). A great number of their holy places and objects were stones, some of them resembling human beings and wearing clothing (Albornoz 1989 [1583/1584]). They sculptured the bedrock, and in some instances they covered it with finely woven, multi-coloured textiles (see van de Guchte 1990:30–32). They set fine masonry so carefully on top of and into the bedrock that nature and culture "amalgamated". They regarded quarries as sacred and worshipped them, and the reasons they gave were that they might not give out and that the buildings they made of their stones might not fall down (Cobo 1990:55, 64, 66 [1653:Bk. 13]).

In inka times, stones had their own lives. Guaman Poma heard about a stone that was so tired by its transportation that it wept tears of blood (Guaman Poma 1980:138–139 [1615:159 [161]–160 [162]]). To this day, there are traces of a belief according to which stone is alive and can transmit force or exert power (for example, Gow & Condori 1982). Métraux tells us how simple blocks of stone are today considered guardians of the village among the Uru-Chipayas people south of Lake Titikaka (1970:73). The view that certain rock outcrops are places of origin of groups of human beings persists today in the Cusco region (for example, Urton 1990:108).

The Allinyana mountain, from where the building blocks for the temple at Ollantaytambo came, is an *apu*, a sacred mountain, a respected lord overlooking the region (see Allen 1988:41–44). Its status as an *apu* most probably dates back to inka times and beyond. On its summit, there are ancient constructions (Robert Randall, personal communication, Ollantaytambo, 1986). Constructions are to be found on many other *apu* summits in the central Andes as well (Heffernan 1988; Reinhard 1988).

Many of them are prehistoric and were apparently used in ceremonies to invoke the spirits and forces.

It is quite certain that the stone at Kachiqhata was sacred even before it was transformed into building blocks, especially so since the mountain itself was certainly sacred. In the Andes, mountains could be described as a human body (Salomon & Urioste 1991), and the mountain/body metaphor is in use to this day (Bastien 1985). It is likely that the stones on the Kachiqhata slope were regarded as the produce of Allinyana's body, and a way in which the mountain fed the people. For the mountain to provide its stones, the stoneworkers most probably fed it in ritual, offering coca, food and drink, while praying for their well-being and for a good outcome of their work.

People living in the vicinity of the Allinyana mountain today say that the mountain can become angry. The notion held by some, that the blocks taken from Kachiqhata to the temple area near Ollantaytambo walked by themselves, is only an expression of the view that nature is alive. A boy who died in Ollantaytambo in 1986 was said to have died from *soq'a*. *Soq'a* is a damaging spirit of the ancestors which can be fatal (Gow & Condori 1982:8, 28). What had happened was that the boy had been playing where there were ancient blocks of stone, near the house where he was staying. Some villagers wondered how the relatives taking care of the boy had dared to live there with the child. Formerly, people used to feed such blocks with offerings, but this custom is falling into disuse. Therefore, the blocks are very hungry, so they take the energy they need from children nearby.

The inkas had a dual concept of the world. The two aspects imbued life (Classen 1993). Andeans of today still conceptualize the world in this way, as can be studied through the Quechua language (Carpenter 1992). As an example, the Inka ruler had a "double", from whom he could seek advice and who could represent him. The double was in some cases a sculptured stone (see van de Guchte 1990:272–294; Polo 1916*a*:10 [1585:Ch. 3]).

The Inkaqonqorina block low on the ramp leading to the temple area is said by local people to be a male block. He has his mate, another block from Kachiqhata, who lies close to the river, in a field by the railroad. She is quite large but not as massive as the Inkaqonqorina block, and she measures a good 7 m in length.[1] Another example is the two boulders which divide the current just above the bridge over the Vilcanota River near Ollantaytambo and serve to protect the central pylon. The larger boulder of the two is said to be male, while the smaller is female. Thus, they are alive in some way, and they are placed in two different spheres or halves. The bridge was built in inka times, and the abutments for anchoring the bridge are still the same. The bridge today has only one crossing but was probably built with two. In the words of Gutiérrez de

Santa Clara, bridges used to have two crossings, one for men and one for women (1964:206 [1595–1603: Bk. 5, Ch. 60]). López de Gómara, an earlier chronicler who was one of Gutérrez de Santa Clara's sources (Wedin 1966:87, n. 290), tells us that the bridge between Iminga and Guaillasmarca had two crossings: one for the Inka ruler, the nobles and the soldiers, and the other for the rest of the people (López de Gómara 1877:27 [1552]).

As pointed out in section 1.3 on "Ollantaytambo and the investigation area", the settlement had and has a crucial location. Geographically and economically, it lay and still lies within reach of different ecological zones, and it was probably important as an intersection for the movement of people, goods and ideas between different settlements in the highlands and the lowlands. Therefore, it is not surprising to find an area intensely exploited in inka times at this spot, as is shown by the extensive terrace systems of inka character, roads with inka characteristics, a planned settlement presumably of inka origin, canalized sections of both the Vilcanota River and the Patakancha stream, a *tambo* function of the settlement, etc.

The erection of the temple near Ollantaytambo may partly be explained by this intense inka presence. At the same time, this does not fully explain its erection in what can be considered part of the heartland of the empire.

Instead, if Ollantaytambo is considered to have been recently integrated into the inka realm when the trapezoidal settlement, the terraces, etc. were constructed, then it is easier to see the need for a temple. Today, it is usually referred to as the Sun Temple. When new lands were conquered by the inkas, a temple dedicated to the Sun had always to be built at important centres, and the inhabitants were obliged to accept the sun cult and also to pay tribute for the servants of the cult. Land would be dedicated for that purpose. A reference, although short, seems to support the idea of lands dedicated to the Sun in the vicinity of Ollantaytambo in inka times (Glave & Remy 1983:8).[2]

The temple near the settlement of Ollantaytambo is not a building forming a house or a yard. Its interior is occupied by the bedrock and by soil, which was probably placed there as an infill. The front wall is battered towards the bedrock. As such inclined walls are typical of the exterior faces of inka structures, the face we see today can quite safely be regarded as being the exterior of a building, as opposed to its interpretation as the interior face of an (unfinished) room. I regard this front wall as being *in situ* and therefore representing part of the original plan of the builders.

One interpretation of the function and layout of the temple may be that it was intended to be similar to that of El Torreón in Machu Picchu, to that of what is now called the Intiwatana structure at P'isaq and to

that of part of Pulpituyoc at Cusichaca (see Angles 1970:40–41, 65–69; Kendall 1974*a*:87–88, 108). In all these three cases, the bedrock occupies the main part of the interior of a room. The rock forming the interior of El Torreón is carved. That is true for the rock forming the interior of Intiwatana at P'isaq as well. In the case of El Torreón, the building with its carved bedrock has been demonstrated to be apt for calendrical purposes. The most striking evidence is an edge sculptured in the bedrock pointing to the rising point of the Sun on the June solstice. At P'isaq, the Intiwatana rock has an edge shaped into the rock, similar to the one sculptured into the rock at El Torreón and with a similar direction (Dearborn & Schreiber 1986:22–25; Dearborn & White 1983).

Among the factors that argue against a similar interpretation in the case of the temple near Ollantaytambo is, firstly, that the shape is different. At Ollantaytambo, the structure surrounding the rock is roughly square; at both Machu Picchu, Cusichaca and P'isaq, the structures have a curved wall. Secondly, the building at Ollantaytambo is filled with soil between the bedrock and the inside walls of the temple, which is not the case in the other structures mentioned here. Thirdly, judging from the parts visible above ground within the circumference of the temple, the rock inside the temple at Ollantaytambo was not carved. The bedrock is not a high-quality rock, but it may well be of significance that the same bedrock within the temple area but away from the temple itself has actually been carved. We should therefore not exclude the possibility that the bedrock in the interior of the temple may be carved. Only further excavations can shed light on this issue.

Since the building near Ollantaytambo was never finished, there might have been a plan to build walls to form a room on top of the bedrock, but the building would in this case have acquired a different architectural character than those at the other sites mentioned. It does not seem likely that the temple near Ollantaytambo was meant to be identical in function to that of the buildings with built-in bedrock at Machu Picchu, Cusichaca or P'isaq. On the other hand, a function related to the sun should not be excluded. Near the time of the equinox, the sun sets behind a ruined building on a mountain spur to the west, as measured from the temple (data provided by the astronomer Curt Roslund, Ollantaytambo and Gothenburg, 1989; also see Hollowell 1987:63). The building is called *Intipunku*, "the doorway of the sun", by inhabitants of the area. Moreover, the name of the spur itself is *Intihuatana*, "where the sun is fastened" or "place or thing related to the solar year" (map made by the Ministerio de Agricultura, sheet no. 27r-IV-SE, Lima, 1975). Possibly the names are of ancient origin and are related to one function of the so-called Sun Temple. Yet care must be taken not to assume that the term *intiwatana* is ancient. The term, as such, was probably used in inka times but was possibly not employed for sculptured rocks of the type now

commonly bearing that name such as the ones at P'isaq and Machu Picchu. For example, at Tipón, there is a spot called Intiwatana but with no such construction. The term may instead be related to sight-lines, since that spot is one of only two points near Tipón from where Cusco can be sighted (Zuidema, personal communication, Urbana, 1993).

More work is needed to clarify the possible relationship between the *Intipunku* building on the mountain spur to the west of the temple near Ollantaytambo, the mountain spur, and the so-called Sun Temple itself.

Possibly, there is furthermore a link between Qorikancha and the temple near Ollantaytambo. Qorikancha is nowadays called the Temple of the Sun, and already Betanzos referred to it as the House of the Sun (1987:50 [1551:Ch. 11]). Qorikancha was at the heart of the empire, built at the confluence of two rivers in *hurin* (lower) Cusco. The temple included, and still includes, various buildings. Within its confines, the image of the Sun was kept (Betanzos 1987:51 [1551:Ch. 11]). Its best-known feature today is a curved wall of fine masonry towards its exterior. The curved wall at Qorikancha links that building to both Pulpituyoc at Cusichaca, the Intiwatana sector at P'isaq, and El Torreón at Machu Picchu. Physical similarities between the temple near Ollantaytambo and the curved-wall section of the Qorikancha include the fine masonry at both places and a location where the ground falls off. At least the lower part of the interior behind the curved wall was occupied by the ground (Rowe 1944:29), a feature reminiscent of the interior of the so-called Sun Temple near Ollantaytambo.

The curved walls are an unusual feature in inka architecture and cannot be explained by the topography but suggest a deeper meaning. Qorikancha, although most widely known as the Temple of the Sun, was not necessarily used for observing the solstices or the equinoxes. Apparently, it was used for observing the sun in May (Molina 1989:66–71 [1573]). The Qorikancha also seems to have been of importance for the chthonic sphere. This is exemplified by the cult of mummies performed at that temple.

That Ollantaytambo played a role in the religious sphere is indicated by Cristóbal de Molina (1989:114–116 [1573]). He tells us that, in the month of December each year, the charcoal and ashes from all the sacrifices made during the preceding year were thrown into the Saphi River in Cusco. The Inka ruler would tell the people present when the residues were thrown in to accompany those residues along the waterway to Ollantaytambo. When it got dark, people along the way would light torches to watch the residues pass and see to it that none of them were left behind. When the residues reached the bridge at Ollantaytambo, people would throw two baskets of coca leaves into the river from the bridge. From that point on, the residues of the sacrifices were left to continue on their own down the river to the sea. The people who had ac-

companied the residues drank and feasted and danced that day, and the next day too. The dance was the *taqui chupayguayllo*, in which a rope was used. *Chupa* means "tail" in Quechua. When the two days were over, the people who had accompanied the residues returned to Cusco, carrying sculptured salt figures in their hands. The mention of the salt figures seems to indicate that a different route was taken back to Cusco, via the salt-extraction centre between Pichingote and Maras and over the mountains, which would at the same time be a short cut (cf. Zuidema 1998). Salt is still being extracted there by means of an ancient system of basins, through which salty well-water is passed. An account written in the year 1650 mentions that the people at the time were making birds, receptacles and other things from the salt there for sale (Contreras 1885:196 [1650]). We have here an example of a ritual round taking place every year. The ritual was a way of thanking the gods for a good year. It shows some similarities to a ritual in May, when they asked for peace and prosperity (Molina 1989:66–71 [1573]). Ollantaytambo lies about 40 km to the north-west of Cusco, and the Pomacanchis lake about 70 km to the south-east, as the crow flies. Ollantaytambo, on the one side, and the Pomacanchis lake, on the other, apparently formed the extremities of the ritual space of Cusco in inka times (see Urbano and Duviols in Molina 1989:n. 35, 120).

Apart from any function as a sun temple or functions similar to those of Qorikancha, another building or concept that seems to have been important, at least at some inka administrative centres, and which should be considered with regard to the temple near Ollantaytambo, is the *usnu*. The term has been applied to more than one physical feature and its meaning or meanings are not crystal clear.

In Gonzalez Holguín's terms (1989:358 [1608]), *usnu* stands for "judge's court [made] of a stone driven [into the ground]" and "landmark when it is of a large stone driven [into the ground]".[3] According to Guillermo Ludeña (1982:250–251), Guaman Poma—the Indian chronicler who had Quechua as his mother tongue—uses the term with the following meanings: "seat of stone, stone driven [into the ground], the Inka's seat in the litter,"[4] and "land destined to sacrifices"[3]. There was an *usnu* in the Hauqaypata Square in *hanan* (upper) Cusco in inka times (Molina 1989:74 [1573]). There was also one in *hurin* (lower) Cusco (Cobo 1990:66 [1653]). Albornoz reports *usnus* in Bilcas, Pucara, Guanaco el Viejo and Tiaguanaco and describes them as towers built of beautiful masonry, where the lords sat down to drink to the Sun, and where they made many sacrifices to the Sun. They could also be made of silver and gold (Albornoz 1989:176 [1583/1584]). They are associated with the platform constructions that are still to be seen in some inka centres (Gasparini & Margolies 1980:264–280).

Tom Zuidema makes an interesting analysis of the *usnu* as a concept, in which the idea of an opening in the ground is central (1989:452). This is in line with Molina's description of the *usnu* in the Hauqaypata Square in Cusco as a basin made of stone lined with gold. In an inka ritual, maize beer was poured into the basin; the beer then ran through a hole in the basin and into a channel which led below ground all the way to the Houses of the Sun, the Thunder and the Creator (Molina 1989:74, 79 [1573]). In Zuidema's interpretation, the earth "sucked" water from the rains through the opening, rains that were attracted to the *usnu* by the winds. *Usnu* would also symbolize the time when the earth was ready to receive the grains to be sown, that is, the beginning of the agricultural season.

There is a piece of land near Ollantaytambo with the name of *Usnopampa*. It lies about 3.5 km west-north-west of the village, on the banks of the Vilcanota River. The name of the field may imply that the land was used for growing plants, in this case probably maize, used in the rites performed at an *usnu*. The name of the field strengthens the idea that there was once an *usnu* at Ollantaytambo. The temple near Ollantaytambo has two features in common with other *usnus*. It is built of well-wrought stones and, although not finished, has a platform appearance. The water channels and the so-called fountains or water basins in the temple area may be worth further analysis in this respect.

It would seem that *usnu* as a concept was always related to the underworld, and therefore also to supernatural powers, to the ancestors, to the other world. In the seventeenth century, the term was apparently used for the channel to a shaft tomb (Zuidema 1977–1978:147). In the department of Ayacucho today, it is used for a cave with mummies but also for a heap of stones attracting moisture, and in Chumbivilcas it is used for a hole in the ground caused by a lightning stroke (Zuidema 1977–1978:157, personal communication, Urbana, 1993). An association between Usnopampa near Ollantaytambo and a hole, maybe where the water is sucked into the ground, should not be excluded.

The location of the temple near Ollantaytambo on a mountain spur with very limited space around it is intriguing. At other inka centres, the platform is located in a large square. If indeed the existence of an *Usnopampa* in the vicinity of Ollantaytambo means that the land was dedicated to the cultivation of plants used as offerings at an *usnu* close by, then an alternative hypothesis is that an *usnu* construction was located in a square that apparently existed in the trapezoidal settlement at the time (Protzen 1993:50–52). The blocks where it would have been located are now built over with residences. Such an *usnu* construction, maybe with a basin and a channel, could have been linked to the temple on the mountain spur. Only excavations could prove the former existence of any *usnu* or other inka buildings in the trapezoidal settlement. In

Cusco, the inka ritual involving the pouring of maize beer into a basin in the Hauqaypata Square mentioned above formed part of the Citua feast in August-September, the time of the year when the first rains started (Molina 1989:73 [1573]; for the months, see Bauer & Dearborn 1995:24–25, Table 2). If similar rites to those at Cusco, although on a smaller scale, were performed at other centres, then at Ollantaytambo, too, we would expect an *usnu* with a platform and a basin, as well as a channel leading away from the basin and to some other important structure.

Even though the location of the temple near Ollantaytambo is abnormal, as compared with other inka centres, it is hardly located where it is by mere chance. Apart from its possible use for calendrical purposes, as mentioned above, I have observed that it is set on what can be described as the prolongation of a line, a line formed by the division between the highly symmetrical, agricultural terraces that lie to the west of the settlement. The terraces in that sector are the most striking ones at Ollantaytambo and were certainly of prime importance. They must have had a value beyond the practical one for agriculture (see Donkin 1979:33). The location of the temple on a line appearing as a marked, physical feature in the terrain may, of course, be a coincidence. When the line is prolonged even more, though, it strikes Ollantaytambo itself, and it strikes the south-eastern section of what was apparently the square in the trapezoidal settlement in inka times and mentioned above. Another line is formed by a straight, built pathway with inka characteristics named *Warankallki* (Yábar 1971:117). It leads between two sets of terraces to the south-west of the settlement. When the line is projected, it, too, crosses the temple area. It was most probably an important communication route for the movement of people and agricultural products between the fields and the settlement, and was maybe used for ritual dancing and processions as well.

Apart from the religious and possibly calendrical uses of the temple near Ollantaytambo, we should also take into account the political motives. According to Geoffrey Conrad and Arthur Demarest, the cult of the royal mummies with the property rights of dead rulers forced a living emperor into a policy of continuous territorial growth (1984:126). The more territory and labour a ruler could gain, the more property would be at the disposal of his *panaqa* (his descent group in the male line), for his cult after his death. Seen in this light, the ruler with the largest territorial expansion would also be the one with the greatest opportunities of initiating major construction works.

Even religion itself, especially the Sun cult, was used for political purposes. The religion was a means of exerting power over the population and, as Gonzales rightly points out (1982:28), large-scale construction in itself could certainly be used to control the population, to organize the

people and to make them participate and dedicate their time and energy to the labour.

Buildings of fine masonry exceed any practical needs. It can be assumed that they were built to endure, since they are of a long-lasting material and since both the material and its careful assemblage into walls have withstood very well the effects of wind, rain, sun and erosion. These battered walls have stood through earthquakes to a remarkable extent, in sharp contrast to simpler constructions (for example, Kubler 1952). Such buildings were then a sign or proof of the might of the Inka ruler who ordered their construction, and they continued as symbols of his power even after his death. Métraux (1970:115–117) saw such buildings, together with well-built roads, as manifestations of vainglory and of prodigality with the strength, patience and time of the Andean peasant.

The links between religion and power, between religion and economy, and between religion and time in the form of a geographically defined, calendrical system were certainly close in Cusco during inka times. Although we do not know exactly how such bonds manifested themselves at Ollantaytambo, we should take their existence into account. The temple near Ollantaytambo can be seen both as a product of such bonds and as a means of creating and recreating them.

[1] This is block no. 22 mentioned in a footnote in section 3.4 on "Labour organization for the stonework at Ollantaytambo: The archaeological evidence".

[2] Originally from the Archivo General de la Nación (Lima), Derecho Indígena; Drawer 614, folio 13v. With 44 folios. "Autos que siguió Juan de Arrendolaza en nombre del Convento y Frailes de Nuestra Señora de la Merced de la imperial ciudad del Cusco, contra don Francisco Mayontopa, cacique principal del repartimiento de Collatambo" (1559).

[3] Vsnu. Tribunal de juez de vna piedra hincada.
Vsnu. Mojon quando es de piedra grande hincada.

[4] Asiento de piedra, piedra hincada, asiento del Inca en la litera.

[5] Tierras destinadas a los sacrificios.

4 SUMMARY

Aim

The aim of this book has been to study aspects of how, when, by whom and why the fine masonry of the Andean region, considered to stem from inka times, was built. It was elaborated as a case study. The so-called Sun Temple and adjacent buildings in the inner temple area of Ollantaytambo in the Cusco Department were used as a starting-point. The construction was not finished, and there are signs of re-arrangement within the site.

The labour process behind the construction was studied, and emphasis was laid on the phases before the actual erection of the buildings. The investigation area included the quarries whence the stone came for the construction, the transportation route and the inner temple area, located on a mountain spur near the Ollantaytambo settlement. The fieldwork comprised both surveys and minor excavations.

Results

The great majority of the building blocks in the inner temple area were extracted from three rock-slides on the Kachiqhata mountain slope at an altitude of about 3,200–3,600 m a.s.l. The rock-slides stem from the almost vertical rock-face of the Allinyana mountain above. The rock-slide areas are located on the opposite side of the Vilcanota River, as seen from the settlement of Ollantaytambo, and about 400–800 m above the valley floor. They are very rich in vestiges of the stonework, both in terms of installations and in terms of blocks in different stages of preparation.

In the rock-slide areas, there are vestiges of how boulders were split, although these examples are very few. It appears that splitting was actually avoided. I suggest that one important reason was that the stoneworkers had no good techniques for this procedure. The rock-face of the Allinyana mountain itself was not quarried. In the instances in which boulders were split, a groove was hammered along either the primary or

the secondary cleavage plane of the boulder. How the final split was achieved remains to be established.

For the rough preparation of blocks, several installations were made in the rock-slide areas. They included a workshop terrace, platforms, flattened spaces, scaffolds and piles of stones. They facilitated the preparation and handling of the blocks, either by providing a more or less flat, working space or by giving access to parts of the blocks otherwise difficult to reach, or by making possible a more convenient posture for the workers.

The trenches that we excavated in the workshop terrace in the northern rock-slide area showed a layer of flakes and stone dust from the preparation, most probably from the preparation of the same large block that lies on the very spot and that was prepared but had been left unfinished. The mineral composition of the flakes and dust in the trenches is the same as that of the Allinyana granitic rock. The flattened spaces also served as workshops. This was proved by the presence of flakes of Allinyana rock in a trench we opened in one such flattened space. The trench was placed between two prepared but unfinished blocks in the western rock-slide area.

The stoneworkers prepared the blocks by striking flakes from the edges and by pounding the block-sides more or less at right angles. In general, the sides were made straight, but the sizes of the blocks were not otherwise altered. The rough preparation did not take place only within the actual rock-slides but also somewhat away from them. Our excavation at a place low down in the western rock-slide area confirmed that it had been used for the storage of some two hundred blocks. It also showed that the storage space had served as a workshop. Flakes from the rough preparation of the blocks formed a layer just beneath the bottom surfaces of the blocks there.

All the vestiges of preparation that we have observed are from mechanical ways of treating the blocks. The few tools that we found were hammerstones. The rounded shape of the hammerstones corresponds well to the marks from the flaking and pounding left on the blocks. Furthermore, the flakes themselves that had been struck from the blocks showed almost exclusively a so-called platform on one of their edges, a platform that corresponds to a tool with a rounded edge. We found only one exception, a flake struck by a tool with a blunt but straight edge, about 5 cm wide.

The distance to be covered in the transportation of the building blocks was about 4–5 km. Between the points of extraction and the valley floor, most of the transportation was downhill. Once on the valley floor, the blocks were moved on almost flat ground to the river bank, taken across the Vilcanota River and then over the rest of the valley floor. The valley floor was mostly slightly uphill. Finally, the blocks were

moved uphill on the Bandolista mountain slope to the spur, where the temple area is located. This is the clearly distinguishable route. Ramps and trails were built for the transportation. The ramps, as defined here, have a clear beginning or end, while the trails form sections in between the ramps. The ramps were built as inclined planes. At the beginning of the route, they are built in the actual rock-slides and lead out of them, converging by degrees. In the continuation, they converge into three trails, which in turn converge into one main transportation trail leading obliquely down the Kachiqhata slope. The ramps and trails may be similar in shape, with a wall on their lower sides and an infill of local material. In the actual rock-slides, the contents of stones and boulders predominate; away from them, finer material forms a major part, and mortar for the wall was also employed there. In some stretches, the ramp and trail surfaces were made concave to facilitate control over the blocks' movements. For the steepest parts downhill, chutes were used, both within and between the rock-slide areas, and for the last stretch downhill to the valley floor. The planners strove to obtain a soft descent in combination with chutes for short stretches. All in all, I recorded twenty-two ramps, six trails and fifteen chutes along the route. On the valley floor, large blocks were left during transportation and can still be seen. They thus serve as indicators of the route followed. The river had to be crossed, but, as far as we could determine by surveying the river shores and the river bed, no installations were made to cross it. My interpretation is that the large blocks were taken through the water, on the bed of the river, during the dry season of the year. In the fields on the valley floor, no trail or other construction for the transportation can be seen above ground. As a result of our excavations between and near blocks there, I conclude that no installations were built on the valley floor for the transportation of building blocks and that the ground was in no way especially prepared for the purpose. For the stretch uphill on the ramp leading to the temple area, the friction was diminished by using thin tree trunks. Rollers were not used. In an excavation under a large block on the temple ramp, eight trunks could be documented. To prepare the trunks, trees had been cut and pruned, but the bark had been left on. The trunks had been placed lengthwise under the central part of the block and in the direction of transport. The "bed" was used as a gliding surface.

Most of the fine preparation took place at the building site, the temple area, and that is where the final touch was given to the blocks. Although the ground in front of the temple has been altered in the present century, we noted that there was stone dust still in the ground somewhat to the side of that open space. The blocks in the temple area show traces of having been flaked and pounded, most probably with small hammerstones. At least one type of tool used had a sharp edge.

There are also traces of honing, a procedure which was usually followed to finish the edges of the blocks, and then most commonly along the edges.

We were able to determine by excavation that the mountain spur on which the temple stands was once flattened with soil brought from elsewhere, presumably at the time of construction of the temple. It also became clear that the two blocks in the front temple wall, near which we excavated test-pits, lacked foundations and had been placed directly on the ground.

We have managed to date satisfactorily some of the events in the stonework by ^{14}C analysis. If we exclude a construction period after the arrival of the Spaniards, we can exclude some of the ranges of the ^{14}C results, and we can narrow others. If we use the one-sigma ranges, we can now say that blocks were transported on the valley floor and low on the temple ramp about A.D. 1440–1530's. One of those blocks would have been moved *c.* A.D. 1440–1490. The construction of the temple ramp took place roughly between A.D. 1450 and the 1530's, and one period of use or construction in the temple area was approximately A.D. 1520–1530's. If we instead apply the two-sigma ranges, the time span for all those features widens to cover *c.* A.D. 1420–1530's. The presence of classical inka ceramics, and inka ceramics following the classical fashion, in our trenches corresponds quite well to such dates. There are also a number of sherds related to the Killke series from the preceding Late Intermediate Period. That may indicate the continued manufacture or use of such pottery in the inka period.

Grave-houses stand on the Kachiqhata slope, and some of them are closely associated with vestiges of the stonework. Our ^{14}C datings show that such grave-houses were built before inka times but continued to be built while the stonework was being executed. It is therefore possible that stoneworkers or people related to them were placed in these grave-houses after death.

Some observations on the relative ages of features could be made. There are crustose lichens that grow quite symmetrically and at a steady and slow rate. They can therefore be used for dating purposes. We found suitable crustose lichens growing on blocks in the rock-slide areas. Those of the same species growing on blocks in the western rock-slide area tend to be slightly smaller than those growing on blocks in the southern rock-slide area. It seems that, of the three rock-slide areas, the western one was the last to be exploited. Another observation on relative ages concerns the ramp leading uphill to the temple area. There, four houses of inka design stand on the ramp. There are furthermore two walls that cross the ramp. The transportation of blocks ceased before these constructions were built. Both the houses and the two walls effectively cut

off access to the temple area and thus prevented any further transportation of blocks up the ramp.

The decision to build fine masonry was not taken by local society. The walls can be seen as expressions of power. The constructions were planned. The planning, though, was not driven to its utmost limits. Rather, there was a somewhat vague plan, which was adapted to new exigencies as the work went on. Field observations have led me to regard the society as a whole as having been one with a mainly vertical system of communication. There was little co-ordination of the work that went on in different sectors, so that it seems that horizontal communication was of limited use or was not sanctioned. There was some scope for individual freedom in the performance of certain tasks. On the other hand, every possible step was not taken to care for the health of the masons. The work meant awkward work postures and problems with flakes and stone dust, apart from the risks involved in moving very large and heavy blocks of stone.

The work was organized so that raw material was extracted, blocks were worked and transported, and constructions were raised simultaneously. It was of an intense character, with a constant flow and provision of building material when the work was going on. Hundreds of blocks were left in different stages of preparation. Such blocks are to be found both in the rock-slide areas, along the transportation route and at the construction site in the temple area. There are signs of a sequencing of the labour process. Blocks were apparently moved one by one, but there were also "stations" for them. The vestiges of the sequencing can be seen both in the rock-slide areas, along the transportation route and in the temple area. The stations were used to prepare blocks, to store blocks temporarily, and to await occasions for further transportation or handling. Sequencing on another level can be discerned as well, namely in the preparation of block-sides. The workers tended to prepare the long sides of the large blocks before they prepared or finished the short sides. Such blocks were banked a quarter of a turn or half a turn during the preparation.

Raw material was chosen with care, and the planners preferred the long, tedious transport of a special kind of rock from a sacred mountain to taking a more common rock for raw material from the vicinity of the construction site. Stone as a building material had a meaning beyond its practical value. In moving blocks uphill, the planners strove to obtain as slight an ascent as possible, without taking too long a way round. There are some indications that the workers were divided into task groups, for example, to construct ramps and to prepare blocks.

The stonework probably went on only during part of the year, namely during the dry season. That was so at least for the work in the quarries and along the transportation route. The thunderstorms on the heights

above Ollantaytambo would have made it very unpleasant and even risky to work in the quarries during the rainy season. Furthermore, during the rainy season the river level rises considerably and to move the blocks across the river would have been much more complicated and difficult than during the dry season. As for the fields on the valley floor, the rainy season is the growing season, and any transportation of building blocks through the fields must, when considering the work force needed, have been highly undesirable.

I have found no published, written information on any groups directly involved in the stonework at Ollantaytambo. Most of the ceramic vessels from which we have recovered sherds were probably made in the Cusco region. That may mean that the stoneworkers came from the Cusco region as well. An alternative interpretation is that the workers, wherever they came from, were supplied with food and drink from state supplies and that the necessaries were provided in vessels that were manufactured in the Cusco region. By studying the written information in combination with toponyms and physical evidence, I have found that Ollantaytambo most probably had a very mixed population in inka times and that there were links between Ollantaytambo and a number of other areas. There are indications of about a dozen groups established at or interacting with Ollantaytambo in inka times.

The settlement of Ollantaytambo had a crucial location. Geographically and economically, it lay, and still lies, within reach of different ecological zones, and it was probably important as an intersection for the movement of people, goods and ideas between different settlements in the highlands and the lowlands. The erection of the so-called Sun Temple at Ollantaytambo may partly be explained by the intense inka presence there, discernible in other remains. Yet another reason may have been that the inkas, as they did in other places, wanted the temple to be built after the incorporation of Ollantaytambo into the inka realm. A temple dedicated to the Sun was always to be built at important centres in recently conquered regions, and the inhabitants were obliged to accept the Sun cult. The Temple may also have been built to serve other religious purposes, as well as calendrical ones. The links between religion and power, between religion and economics, and between religion and time in the form of a geographically defined, calendrical system were certainly close in Cusco during inka times. Although we do not know exactly how such bonds manifested themselves at Ollantaytambo, we should take their existence into account. The so-called Sun Temple at Ollantaytambo can be seen both as a product of such bonds and as a means of creating and recreating them.

RESUMEN EN ESPAÑOL

Propósito

El proposito de este libro ha sido estudiar aspectos sobre cómo, cuándo, por quiénes, y por qué, los muros de piedra meticulosamente tallada de la región andina y considerados ser de la época inka, fueron construidos. El proyecto fue elaborado como un estudio de caso. El llamado Templo del Sol y construcciones adyacentes en la parte central de la zona del templo de Ollantaytambo en el departamento de Cusco, Perú, sirvieron como punto de partida. La construcción no llegó a ser terminada, y hay indicios de reorganización dentro del sitio.

Estudiamos el proceso laboral poniendo énfasis en las fases anteriores a la erección de los edificios. El área de investigación incluye las canteras de las cuales provenían las piedras para las construcciones, la ruta de transporte, y la zona central del templo, la cual está ubicada en un saliente de un cerro al lado del poblado de Ollantaytambo. El trabajo de campo comprendía tanto reconocimiento como excavaciones menores.

Resultados

La gran mayoría de los bloques de piedra para las construcciones en la parte central de la zona del templo fueron extraídos de tres derrumbes en la ladera llamada Kachiqhata, a una altura sobre el nivel del mar de alrededor de 3,200–3,600 mts. Los derrumbes provienen de desprendimientos de una vertiente rocosa casi vertical del cerro Allinyana, que está por encima de la ladera. Las diferentes zonas de derrumbe están ubicadas al lado opuesto del río Vilcanota, visto desde el poblado de Ollantaytambo, a aproximadamente 400–800 mts. sobre el fondo del valle. Estas presentan abundantes vestigios del trabajo de piedra, tanto en lo que se refiere a instalaciones como en lo que se refiere a bloques de piedra en distintas fases de tallado.

En las diferentes zonas de derrumbe hay vestigios de cómo fueron partidas las piedras, aunque los ejemplos son pocos. Aparentemente, los picapedreros evitaban el procedimiento de corte. Una razón significativa

APPENDIX

Some notes on the geology of the Ollantaytambo area of southern Peru

By Sven Ahlgren

Abstract

The village of Ollantaytambo has been regarded by many archaeologists and historians as an important settlement in the inka empire (see, for example, Gasparini & Margolies 1980 and Hyslop 1990). It is situated in the Vilcanota River Valley, some 43 km, as the crow flies, north-west of Cusco, the capital of the inka empire. The village is situated in a strategically important position and is the site of a planned settlement, impressive agricultural terraces and a temple. These structures have been built using stone from several sources within the region surrounding the village. In this study, the investigation is concentrated on the temple of Ollantaytambo, the quarries on the mountain slope of Kachiqhata on the opposite side of the Vilcanota River, and the transportation route between the quarries and the temple. However, the object of the geological study is not so much these sites as the blocks of red, granitic rock that were used in building the temple and the blocks that still today lie scattered in the quarries, along the transportation route and in the temple area itself. To complement the study, the origins and applications of several other types of rock used as building material at Ollantaytambo have also been investigated.

Aim of the geological investigation

During the field seasons of 1985 and 1989, I made a geological study at the village of Ollantaytambo in the Andes of southern Peru. The aim of the study was to support the archaeological work of Lisbet Bengtsson in the village and its surroundings. This being the case, no attempt at a comprehensive geological survey was made in and around the village.

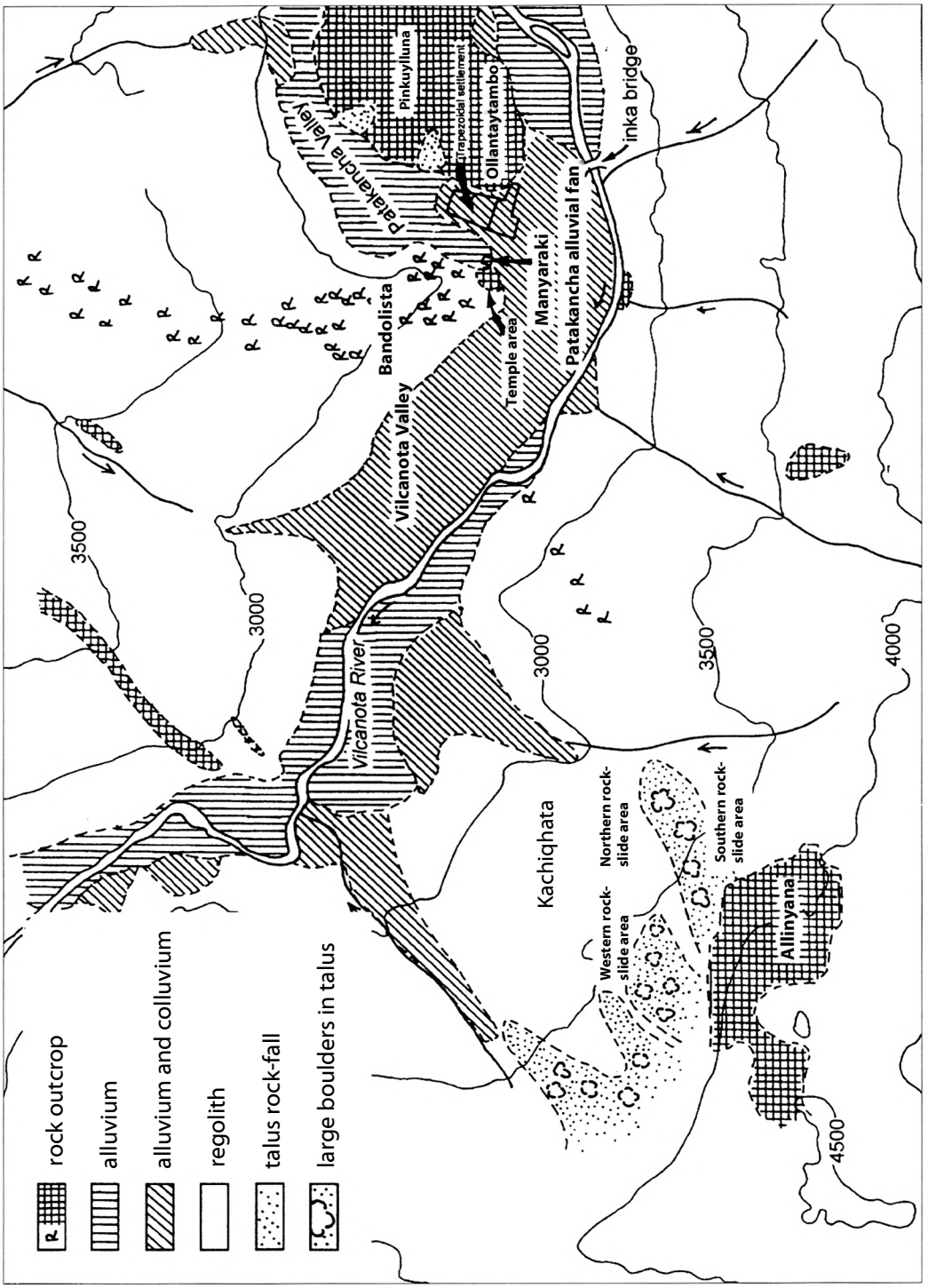


Figure 1.
Map of the studied area with the results of the geological survey. (Drawing by Anders Andersson)

Rather on the contrary, only the geological features considered to be of relevance to the archaeological work were investigated. The geological study centres on the relation between the stone used for the building of the pre-Columbian, so-called Sun Temple at Ollantaytambo and the source of this stone, the quarries on the Kachiqhata mountain slope some 4 km away on the opposite, south-western side of the Vilcanota River. For further orientation, see the map (Figure 1).

Fieldwork was carried out during May and June 1985 and during May 1989. The work was divided into two phases. Firstly, buildings, walls, agricultural terraces and other structures built of stone and of presumed pre-Columbian origin in and around Ollantaytambo were visually inspected. Secondly, exposed bedrock, boulders in rock-falls, talus, regolith and alluvial sediments were inspected and in some cases sampled for later analysis. Though concentrated on the Sun Temple and the Kachiqhata quarries, the study also dealt with other aspects of the use of stone as a building material in and around Ollantaytambo.

Rock or stone and geology in general are often quite difficult or obscure subjects to the archaeologist. Lisbet Bengtsson realized this and asked me, who had studied mainly Scandinavian Quaternary geology and some mineralogy and petrology before turning to archaeology, if I could assist her during her fieldwork at Ollantaytambo. I had, for as long as I could remember, dreamed about going to South America and to Peru in particular and immediately decided to accompany her to Ollantaytambo. Since then, I have been several times to South America, and the last words were actually added to this manuscript in San Miguel de Tucumán in north-western Argentina during the southern winter of 1997.

At Ollantaytambo, I attempted to elucidate, at least partially, two general questions. Firstly, where did the stone used during construction work at the village come from? Secondly, how was the stone used? Was stone used randomly during building or were special types of stone used in specific constructions? As Bengtsson's work was centred on the red, granitic rock from the Kachiqhata slope used in the temple at Ollantaytambo, this was also my main focus. But was this stone used at other building sites in or near the village as well? This question widened the scope of the investigation and in the end at least some answers emerged from my work.

I am well aware of the work done by Protzen (1993) at Ollantaytambo. I have cited it a few times and freely acknowledge that it could have been cited many more. It will become obvious that we do not agree on all points regarding the geology of Ollantaytambo. But this is no great matter, and future research will show who was right or wrong, and, of course, we may both be wrong. Maybe it should be pointed out that we have never met, have worked fully independently of each other, and

have never had the opportunity to exchange views on the remarkable archaeological site of Ollantaytambo and its surroundings.

The same may be said about the work of Hollowell (1987). We actually met very briefly at Ollantaytambo, but this did not in any important way influence my work there. Regrettably, I was unaware of Hollowell's report on Ollantaytambo until just a few days before going on a six-month research trip to Argentina. I have not been able to study it in full, but during the last revision of this text a few notes on some of Hollowell's results have been added.

Any serious omissions as regards the geology of the area or the stonework on the archaeological sites are, at least in part, the result of the limited time available. Also, they are to some extent the result of my failure to take down notes on matters that, with the benefit of hindsight, should have been recorded.

Many of the geological terms, often quite obscure to the archaeologist, are explained in the wordlist. Apart from a few cases, I have followed *The Penguin Dictionary of Geology* in preparing the wordlist (Whitten with Brooks 1981). In the cases in which I have not followed Whitten with Brooks, the definitions, as is indicated in the wordlist, are my own or Bengtsson's (in this volume).

The expressions *boulder* and *block* have special meanings in this text that are far removed from any geological use. A boulder is a piece of rock that has not been prepared or worked on by man in any way. A block, on the other hand, has in one way or another been prepared by man. If applied strictly, this means that a boulder that has had one small rock fragment removed before use is turned into a block. Of course, such a block can hardly ever be distinguished from a boulder. In reality, it has often been impossible to decide whether a rock has been slightly worked on and hence is a block and not a boulder. A fully consistent use of the two terms would have made the text very difficult to write and horrible to read. As things stand, there are many small inconsistencies in this text, and for these I alone am fully responsible.

The physical geography of the Ollantaytambo area

The village of Ollantaytambo is situated in the Vilcanota River Valley of the Vilcanota mountain range in the eastern Andes of Peru, at slightly above 2,800 m a.s.l. (metres above sea level). The Valley is surrounded by mountains reaching some 4,800 m a.s.l. In this part of Peru, the valleys generally run in a west-north-westerly direction, but at Ollantaytambo the Valley takes a slight bend. Locally, the valley floor is some 250 to 900 m wide and is dominated by river terraces, alluvial plains, and colluvial and alluvial fans. At the most, the relief of the valley floor reaches heights of 75 m but is generally less than this. The up-to-2,000-m-high

mountainsides surrounding the valley bottom are steep and typically inclined about 30° from the horizontal. Often the slopes are steeper and occasionally approach a fully vertical configuration.

At Ollantaytambo the Patakancha Valley enters into the Vilcanota Valley from the east-north-east. It is a minor valley, considerably narrower than the Vilcanota Valley. None the less, it is surrounded by steep, often very steep, up-to-2,000-m-high mountainsides. Some 18 km, as the crow flies, north-north-east of Ollantaytambo, it reaches a pass and from that point on, the terrain drops to Lares and then to the Yanatili River in the subtropical rainforest. The waters of both the Yanatili River and the Vilcanota River eventually find their way to the Amazon River. If, on the other hand, the Vilcanota Valley is followed towards the south-east, its beginnings will be found some 190 km away in the Vilcanota mountain range.

The bedrock on the sides of the Vilcanota and Patakancha Valleys is normally covered by regolith, that is, a more or less thick cover of debris produced by weathering and erosion of the bedrock. The regolith almost totally covers the bedrock, except on very steep inclines. Large exposures of bedrock occur only in the steep-sided entrance of the Patakancha Valley into the Vilcanota Valley and on the large, very steep rock-face above the quarries on the Kachiqhata mountain slope. Apart from this, there are not very many, even small exposures that can be reached from the valley floor without considerable effort.

The bedrock at Ollantaytambo

The area covered by the geological survey is small. It consists mostly of the lower elevations of the Vilcanota Valley from some 3 km west to 1 km east of Ollantaytambo. The mountainsides at the opening of the Patakancha Valley into the Vilcanota Valley have been investigated to a considerable height above the valley floor. The western side above the Sun Temple at Ollantaytambo was surveyed up to 4,800 m a.s.l., and the eastern side to 3,300 m a.s.l. Further to the north-east, the survey of the Patakancha Valley was very limited, as there are very few places where the bedrock is exposed reasonably close to the valley floor, and the time available for the survey was limited. Actually, reaching one single bedrock exposure might take up most of a working day.

The bedrock at Ollantaytambo is part of the Mito group, of Permian age, which covers considerable expanses of the Cordillera Oriental. At Ollantaytambo, the rock group consists mainly of andesites, rhyolites, tuffs, agglomerates with fragments, and blocks of spilites, that is, basaltic rock often in the form of pillow lavas, and sandstones (Kalafatovich 1964–1965:38). Several other works could be cited here, but the one by Kalafatovich, a geologist by profession, is regarded as quite sufficient.

The bedrock on the northern side of the Vilcanota Valley

The bedrock examined on the northern side of the Vilcanota River Valley is, as previously mentioned, mainly exposed on the two mountains flanking Ollantaytambo at the mouth of the Patakancha Valley. To the west, Bandolista, where the Sun Temple is situated, rises to about 4,900 m a.s.l and more than 2,000 m above the valley floor. To the east, Pinkuylluna, with the famous group of three stepped houses among other pre-Columbian buildings, reaches more than 600 m above the Vilcanota Valley floor and 3,500 m a.s.l.

As regards the bedrock, the two mountains are quite different from each other, though both are made up of mainly volcanic sequences. Pinkuylluna, extending roughly 2 km to the east between the Patakancha and Vilcanota Valleys, is very steep-sided, with 45° to 85° and even fully vertical inclines. Along the Vilcanota Valley, the lowest part of the mountain consists of a green and, higher up, a greenish-red, intermediary lava. About 200 m above the river, and almost to the top, this is superseded by a pale greenish-white, acid, partly brecciated lava. This rock type was also encountered in a rock-fall, including some very large boulders, on the Vilcanota Valley floor some 2 km to the east below the crest of Pinkuylluna. Here, at the foot of Pinkuylluna, and extending some 400 m to the west, the local bedrock is a greyish-red, acid to intermediary, volcanic rock.

It should perhaps be pointed out that some of the rocks described as lavas are almost certainly in reality tuffs. However, no far-ranging attempt was made to distinguish between lavas and tuffs during fieldwork, but no immediately obvious tuffs were encountered.

The bedrock of the Bandolista will be described in essentially two sections. Firstly, the part on which the temple area and the terraces and ruins between the temple area and Manyaraki Square are situated is discussed in some detail. Secondly, the rest of the mountain is described in a less detailed section.

The bedrock north-west of Manyaraki Square is mainly made up of volcanic rock of granodioritic to dioritic composition, ranging from grey to green and reddish-green. However, some minor acid sections make up part of the rock. Some rock units consist of fine-grained stone only or contain more or less scattered phenocrysts. Often the rock contains xenoliths, made up of either seemingly fresh rock or more or less dissolved fragments. In some cases, only an indistinct shadow in the rock is all that remains of the xenoliths. Some of the rock is formed as a breccia. It contains a multitude of broken-up, sharp-edged, volcanic rocks, often of several different types and sizes from the very small to about 0.5 m. Most of the rock in the temple area is here considered to be andesitic, that is, as

volcanic in origin, but there are almost certainly some exceptions to this. The strike and dip of the rock are highly variable, from the almost horizontal to the vertical, and it seems likely that at least the vertical and greatly to moderately inclined rock units intruded into the rock well after it formed as a succession of lava flows.

Above the temple area, Bandolista rises to about 4,900 m a.s.l. A survey along the south-eastern spur, from above the temple area and to a height of 4,825 m a.s.l, revealed a 2,000-m-thick sequence of volcanic and sedimentary rock. From the bottom of the Vilcanota Valley at a point somewhat to the north-west of the temple and up to 3,200 m a.s.l., the bedrock consists of mostly red, acid lavas. From 3,200 to 4,300 m follows a complex suite of mostly fine-grained, but partly porphyritic acid and intermediary lavas. These have, in turn, been intruded by intermediate rock with a breccia-like structure secondarily cemented by calcite. Between 4,300 and 4,825 m, the bedrock is made up of conglomerates containing acid and intermediary volcanic material only.

The sequence of volcanic rock on the spur of Bandolista may seem to be quite straightforward, but the geology is rather more complicated than this. Down to about 300 m, immediately above the temple area, the bedrock is essentially like that described above. Below this, the bedrock consists of a 200-m-thick unit of a green, partly brecciated diorite. The last 100 m down to the bottom of the Vilcanota Valley, just south-west of the temple area at 2,850 m a.s.l., is made up of massive, dark-green, dioritic rock. These two intermediary or dioritic units are believed to be intrusive into the sequence of lavas previously described and should probably be seen as parts of one single unit.

The bedrock on the southern side of the Vilcanota Valley

There are several bedrock exposures along the southern side of the Vilcanota Valley, both along the course of the river and higher up on the mountainside. Unfortunately, the time available did not allow the higher-lying, bedrock exposures to be visited.

A modern bridge built on inka foundations crosses the Vilcanota River at Ollantaytambo. For simplicity, it is referred to below as “the inka bridge”. There are several bedrock exposures between about 0.3 km west to 0.7 km east of the inka bridge. The exposures that have been examined extend up to some 150 m above the river plane. They are made up of acid and intermediary, fine-grained, porphyritic lavas. The colour of the rock ranges from black to grey, green and red.

Observations on large boulders fallen from the partly very steep slopes above the area indicate that the bedrock is essentially of the same type as that close to the river itself, possibly many hundreds of metres up the

slope. However, some large boulders found about 0.3 km west of and 150 m above the inka bridge reveal the presence of sedimentary bedrock units, possibly many hundreds of metres or even a thousand metres or more above the Vilcanota. The boulders are made up of sandstone, limestone, agglomerates, conglomerates and a rock resembling a greywacke.

The bedrock and rock-slides of the Allinyana mountain

The Allinyana mountain on the southern side of the Vilcanota River is the source of the red, granitic rock used as building material in the Sun Temple and at some other sites in Ollantaytambo. Allinyana is not a solitary mountain, it is merely a somewhat prominent part of the southern side of the about-2,000-m-high mountainsides of the Vilcanota Valley. In all, Allinyana rises to about 1,700 m above the Vilcanota. The lower 900 m of the mountain are covered partly by regolith and partly by talus cones or rock-slides. The regolith and talus cones are made up of rock material fallen from the 600-m-high, very steep rock-face overlooking the river and Ollantaytambo on the opposite side of the valley. The red, granitic rock originating in the Allinyana rock-face was actually quarried in the rock-slides. The slope with rock-slides is called Kachiqhata by those living in the valley and this name will be used in the discussion below.

Three rock-slides are described here. Within the eastern talus cone, only two distinct sections have been quarried. Here, they are referred to as the southern and the northern rock-slides. West of these lies the western rock-slide.

Unfortunately, the Allinyana rock-face is quite difficult to reach, and no time was available for a closer inspection of the outcrop. The description given here is based on observations made on boulders in the rock-slides only. The bedrock varies in several ways. The colour ranges from red to grey to almost white. The graininess varies from the relatively coarse, or about 10 mm in size, of the southern rock-slide to sections consisting of fine-grained rock. Also, the crystals in the groundmass of the rock vary in size, from those easily discernible with the naked eye to the almost amorphous, even under a 8× hand lens. The chemical composition of the rock, however, shows little or no variation. Examinations of many specimens in the field and of thin sections by Stefan Klingberg (personal communication, Göteborg, 1987) at the Department of Geology, Göteborg University/Chalmers University of Technology, in Sweden, have both verified that the rock is of granitic composition.

In hand specimens, the texture of the rock, with often relatively small crystals and a fine-grained groundmass, suggests that this rock solidified close or even very close to the ground surface, an observation confirmed

by Klingberg. Actually, some of the boulders on the slope have an almost, but not quite, rhyolitic appearance. Thus, the rock of the Allinyana rock-face is considered to be part of an intrusion of molten rock of granitic composition that displaced the surrounding rock at a shallow depth below the ground surface. It is tempting to call the intrusion a batholith, but, as pointed out by Klingberg, its shallow depth of solidification and almost rhyolitic appearance invalidate the classification of the rock body as a batholith. Also, a batholith is by definition a rock body with a considerable, observable outcrop, actually many square kilometres in area, and it should have no observable bottom (Whitten with Brooks 1981:49–50), both characteristics that the Kachiqhata intrusion probably lacks. Actually, there is a small outcrop of a greyish-black, rusty, argillaceous shale just below the western rock-slide, seemingly limiting the size of the granitic rock body, at least downwards. In the following pages, the granitic rock body will simply be called an intrusion.

Protzen considers the rock to be rhyolitic (1993:39), but, as he states in his work on Ollantaytambo, he earlier regarded it as granitic (1993:40, note 12). In a sense, he may have been right on both occasions. Though most of the rock in the rock-slides has the characteristics of an intrusion, some of it is almost rhyolitic in appearance. Hollowell considers the red rock of Allinyana mountain to be a dacite (1987:44, 120). If he is correct, the rock is not of granitic, as is argued here, but of dioritic or granodioritic composition and is a lava and not an intrusion. As is pointed out by Hollowell, the investigators of the Allinyana rock have reached several conflicting conclusions (1987:44). However, to the stonemasons of the past the arguments about the scientific classification of the rock at the present time make no difference and to the archaeologist, the distinction between a granitic intrusion and a rhyolitic lava flow is no great matter.

The rock-slides of the Kachiqhata slope are of considerable size and have been active over a long period of time, possibly many tens of thousands of years. They are still active, as is shown by a large rock-slide in the early 1970's. There are also many small rock-slides and individual rock-falls at practically all times (Lisbet Bengtsson, personal communication, Ollantaytambo, 1985). The talus cones are made up of many individual slides, as is indicated by the different degrees of vegetation cover over different parts of the cones. The large eastern cone, of which the northern and southern rock-slides are part, is about 1 km long, 300 m wide and extends over 600 m in height. The western rock-slide is smaller, at about 700 m in length, 400 m in width and 500 m in height. There are several more rock-slides further to the west, but I do not need to deal with them here.

Many of the blocks in the southern rock-slide are well within the mineralogical range encountered in the Sun Temple. Primarily, large blocks were extracted from this part of the Kachiqhata slope, as the spacing between the joints in the bedrock is quite wide and there is a tendency for large blocks to form whenever there is a major rock-slide from the cliff face. The largest boulders in the southern rock-slide exceed 8×3×3 m in size.

The rock of the western rock-slide is essentially like that of the southern rock-slide. The only difference that can be seen in hand specimens is that the crystals of the rock tend, on the average, to be slightly smaller here. However, there is one important difference between the eastern and western parts of the Allinyana rock-face. Within the western part of the rock outcrop, the spacing between the naturally occurring joints is much smaller than that within the eastern part. The boulders falling from the western rock-face therefore tend to become relatively long and narrow. The most extreme, prepared block found in the western rock-slide is actually 12 m long. Blocks over 6 m in length are as thin as 0.4 m (Lisbet Bengtsson, personal communication, Ollantaytambo, 1985).

Apparently, only the red rock of the Kachiqhata rock-slides was utilized in the Sun Temple at Ollantaytambo. However, a relatively small number of blocks of this type were also used in other buildings or structures in or close to the village. For whatever reason, technical or other, the less reddish, grey and almost white varieties of rock were excluded from use by the builders of the Sun Temple. But this seems to have been the rule also in the village buildings, terraces and other structures at Ollantaytambo. However, according to Protzen (1993:251) a few blocks of fine-grained, grey rhyolite, almost certainly from the Kachiqhata slope, are included in the door jambs of the unfinished gate leading to the inner temple area, as will be described later.

The bedrock of the Patakancha Valley

The bedrock of the Patakancha Valley was observed almost exclusively in the form of boulders fallen from the often very steep mountainsides surrounding the valley bottom. This was done during a one-day survey, reaching about 7 km up the valley.

The main constituent of the bedrock seems to be greenish, intermediary volcanics. Other rock types present are breccias containing mainly acid, rock fragments of volcanic origin, and slightly metamorphosed, dark shales. Additionally, the presence of red, acid conglomerates and porphyritic, acid volcanics higher up on the mountainsides is indicated by the boulder material on the valley bottom. Generally, the survey hints at a composition of the bedrock rather similar to that encountered during

the ascent of the Bandolista mountain above the temple ruins of Ollantaytambo.

The alluvium of the Vilcanota River Valley

Here only the boulders of the alluvium are considered, as they make up a considerable part of the blocks and boulders in many pre-Columbian terraces, retaining walls, other walls, structures and buildings at Ollantaytambo and in its vicinity. In this context, boulders are considered to be fragments of rock in which the longest side is more than 0.256 m. The very exact number refers to the definition of a boulder on the internationally acknowledged, Wentworth-Udden, particle-size scale. Of course, during fieldwork, the size of a boulder was defined much less exactly.

A survey of the boulders in the Vilcanota River alluvium was made some 1.3 km west of Ollantaytambo. The many, well-rounded boulders lie scattered between the river and the track of the Cusco-Quillabamba railway some 50 m to the north-east. A clear majority of the boulders consisted of grey and red, acid and intermediary volcanics. The remainder of the boulders was a mixture of conglomerates and occasional sandstones, grey, fine-grained sediments, breccias, agglomerates and a small but diverse assortment of metamorphic rock types.

In a second survey, about 100 m west of Ollantaytambo railway station, the boulder material of the Vilcanota alluvium was found to be much like that described above. The only noticeable difference was the even greater predominance of grey and red, acid and intermediary rock of volcanic origin.

To a considerable extent, the sediments of the river plains in the area are filled with a mixture of alluvium and what I have chosen to call colluvium. The colluvium is formed by regolith from the sides of the valleys that has been brought into the river plain by the force of gravity or by the action of water. The boulders of the colluvium have been transported a short distance only and are normally angular. The more well-rounded boulders of the alluvium have often been transported for a much greater distance. It is very likely that boulders of the colluvium were used as building material at Ollantaytambo. However, any such boulders would, of course, be indistinguishable from other boulders collected on the mountainsides above the river plain.

The Patakancha Valley alluvium

Alluvium from the Patakancha Valley makes up the alluvial fan on which much of the agricultural land of Ollantaytambo is situated. The valley is only about 19 km long and the variation in the boulder material is relatively limited. The alluvial sediments are made up of essentially the

same types of rocks as those found among the boulders that have fallen from the high mountainsides of the valley, described above.

Observations on blocks and boulders in and around Ollantaytambo

Were the blocks from the Kachiqhata quarries used exclusively at the Sun Temple at Ollantaytambo or were they used at other construction sites in the area as well? In an attempt to answer this question, I give below the results of a survey of the blocks and boulders that went into a number of presumably pre-Columbian buildings and other structures in and close to Ollantaytambo. It is assumed, without further comment, that all the buildings and other structures discussed here are of pre-Columbian age or at least that they were erected by the inka polity before the final take-over of the region by the Spaniards.

Bedrock, boulders and blocks are often difficult to classify, as they are weathered and, above all, often heavily overgrown by lichen. Bedrock and boulders may have a piece struck off with a geological hammer to facilitate a closer look at the unaltered rock. Any such sampling of blocks was avoided. This makes some rock determinations made in the field insecure. Nevertheless, it is generally felt that the overwhelming majority of the determinations made are sufficiently exact to fulfil the aims of the investigation.

Structures outside the temple area and the village of Ollantaytambo

The boulders in the agricultural terraces, just north of the railway track between the Ollantaytambo railway station and the inka bridge, are of local origin. The overgrowth of lichen makes many of the boulders difficult or impossible to identify. However, the majority of the boulders consist of porphyritic lavas, although there are some sandstones and conglomerates. The distinctly rounded boulders originate from the Vilcanota and/or Patakancha alluvial deposits. At least the sandstone boulders have, almost certainly, been taken from the alluvium of the Vilcanota, as no such boulders have been encountered in the Patakancha alluvium.

East of the inka bridge, on the southern side of the Vilcanota River, the agricultural terraces, the embankment of the river up to the Choqana ruins, and Choqana itself, have been constructed almost exclusively from local blocks and boulders. Most of the blocks are angular and originated from local bedrock, rock-falls or other loose rock. A few boulders have been taken from the Vilcanota River alluvium. A small number of blocks may be from the Kachiqhata rock-slides, but this is very uncertain, as no direct comparison was made between rock from the constructions close to the inka bridge and the quarries. The mid-river foundation of the inka

bridge crossing the Vilcanota at Ollantaytambo consists mainly of blocks of red, acid, porphyritic, volcanic rock. Of the blocks that could be scrutinised at close range, without risking falling into the river, only one was of a different type. This block is made up of a green, volcanic rock with large vesicles, a rock type not encountered anywhere else during work in the area.

The three houses of the stepped-house group, situated on the lower part of the Pinkuylluna mountain, were constructed mainly from local angular blocks but also include a few rounded boulders from river alluvium. In addition, there are a few blocks that may have originated in the Kachiqhata quarries. Several other ruins on Pinkuylluna were constructed of boulders from the local bedrock only.

The terrace walls that delimit the eastern part of the Patakancha alluvial-fan deposits towards the alluvial plain north of the Vilcanota River contain a rather angular, rock material. Most of the boulders are likely to have come from the fan itself. Few, or none, of the boulders in these walls seem to have originated in the alluvial sediments of the Vilcanota.

Inkapintay is situated where the Vilcanota alluvial plain is at its narrowest, about 1 km east of Ollantaytambo. The now ruined building there was constructed from quite large, angular boulders. As far as could be seen, the boulders originated from the local bedrock or, more likely, from slightly worked boulders thereof.

Some 1.3 km west of Ollantaytambo, a seemingly solitary stone wall has been erected between the Vilcanota River and the track of the Cusco—Quillabamba railway, about 50 m to the north-east. The wall is made up of rounded boulders, in all likelihood from the river-bed. But, as the boulders are almost totally overgrown by lichen, it is impossible to say anything with certainty about their origin. Nevertheless, the wall seems to be one of many examples that, when possible, local material was normally used for structures built of stone.

Another seemingly solitary wall is situated some 500 m further on in the direction of Ollantaytambo but on the opposite, north-eastern side of the railway track. It is made up of rounded blocks, essentially of the same mix as that of the Vilcanota alluvium. As far as could be observed, no boulders from other locations were used in the wall.

Two large blocks of Kachiqhata type are situated in the gate of the Ollantaytambo presbytery. There are more blocks of this type, which, regrettably, I have not seen, within the confines of the church and presbytery (Lisbet Bengtsson, personal communication, Ollantaytambo, 1989).

The temple area, the temple ramp, the transportation route for blocks at Ollantaytambo and the sector between the temple area and Manyaraki Square

Here, the temple area is divided into two parts, the inner temple area with the Sun Temple and the outer temple area. The inner temple area has seen the extensive use of red, granitic rock from the Kachiqhata quarries. In the outer temple area, another type of stone was employed as building material, and the Kachiqhata rock had a very limited use. For definitions of the two areas, see the text of the present volume (see section 1.3 on "Ollantaytambo and the investigation area" and Figures 5 and 61).

The ramp leading up to the temple area along the side of Bandolista mountain, and the transportation route between the Vilcanota River and the lower end of the ramp are also treated here, as they together make up part of the route along which the red, granitic blocks from the Kachiqhata slope were transported to the temple area.

The sector between the temple area and Manyaraki Square has been included, under its own heading, in this part of the description, as these terraces and ruins, without any interruption, are situated on the same slope as, and just below, the temple area.

The inner temple area

Little need to be said about the red, granitic blocks of various sizes from the Kachiqhata quarries in the inner temple area. Here, it is sufficient to say that there can be no doubt whatsoever that these blocks originated on the Kachiqhata slope.

There are several, more or less reddish types of rock among the ruins of Ollantaytambo that could, at least superficially, be confused with the rock coming from Kachiqhata. These reddish, non-Kachiqhata rock-types, as a rule, have at least a slightly different colour, a groundmass often totally amorphous to the unaided eye, and relatively small phenocrysts. Additionally, they tend to contain more xenoliths than the rock in the Kachiqhata rock-slides. However, none of these Kachiqhata look-alike blocks have been found in the inner temple area.

The outer temple area

The outer temple area includes the hall of the ten niches (actually with a wall missing towards the south-east), its gate towards the south-east, the four retaining walls, and the three terraces just below the hall. Included are also the wall of the unfinished gate and the gate itself, which leads to the inner temple area above. To this are added some very spectacular terraces south of the hall of the ten niches at the termination of the large

ramp. Almost all of the stone in these exquisitely crafted structures consists of very finely worked, deep red to black, acid rock. It is relatively fine-grained and seems, at least in part, to have an amorphous to very fine-grained groundmass. According to Protzen, this rock is a welded, rhyolite tuff, which it may very well be (1993:82, 251). An acid rock of volcanic origin, whether a lava or a tuff, it most certainly is.

These blocks are likely to have come neither from the Kachiqhata slope nor from any other rock outcrop, rock-fall, talus or river alluvium in the vicinity of Ollantaytambo seen by me. Quite possibly, they are from an unknown quarry, somewhat removed from Ollantaytambo. Protzen argues that the rock type may be from a rock scree on Pinkuylluna, north-east of Ollantaytambo (1993:158). This would mean along the eastern side of the Patakancha Valley. While I did not see this particular site, I did not see any rock of this type on the part of Pinkuylluna which I surveyed.

Hollowell considers the rock to be a dacite (1987:45, 120). I have no thin sections to back up my description of the rock and, considering its dark colour, Hollowell's determination may very well be correct. As opposed to Protzen (1993:158), both Hollowell (1987:45) and I consider the source of the rock to be unknown.

Protzen states that the four door jambs of the unfinished gate leading to the inner temple area are made of fine-grained, grey rhyolite. I have no notes on this; I must have missed it while standing there in front of the gate, making notes. Protzen considers it likely that they are from the Kachiqhata quarries (1993:251). The step stone of the gate, on the other hand, is a typical example of a block from the quarries of the Kachiqhata slope. Hollowell mentions the step stone as being from Kachiqhata but, unlike Protzen (ibid.), considers that the other parts of the gate are made up of the same dacite as the rest of the outer temple (1987: 67–68).

The temple ramp

Along the lower, south-western side of the Bandolista mountain spur, a ramp of considerable size leads up to the temple of Ollantaytambo. The blocks and boulders that make up the outer wall of the ramp are of non-local origin and have all, or almost all, been transported there. About 30% of the blocks are rounded or well rounded. The remaining 70% are angular or just slightly rounded. Possibly most of the blocks originated on the Patakancha alluvial fan, and to some extent in the Vilcanota River alluvium. The ruined buildings standing on the upper part of the ramp are made up of the same mix of blocks as the ramp itself.

Observations on the prepared blocks along the transportation route between the Vilcanota River and the temple ramp

With four exceptions, all the blocks along the route from the Vilcanota River below the Kachiqhata slope to the temple ramp seem to have originated in the southern rock-slide of the Kachiqhata slope. Two, small, prepared blocks, with relatively small crystals, probably originated in the western rock-slide. A third, irregular block with small crystals is also likely to be from the western rock-slide. The fourth block, dark red in colour, is in all likelihood not from Kachiqhata at all, but from some altogether different locality. But, as the block is heavily overgrown with lichen, the non-Kachiqhata verdict is slightly uncertain.

The sector between the temple area and Manyaraki Square

The rock in the walls and the quite large number of scattered rocks and boulders between the temple area and Manyaraki Square consist of a mixture of mostly locally obtained blocks. The material is made up of angular and rounded blocks and boulders. The angular boulders were obtained from rock-falls, talus and possibly bedrock lying relatively close to the temple, but the mixture is heterogeneous enough to indicate that a relatively large, surrounding area was searched for suitable material. The more or less rounded material seems to have originated from the alluvial deposits at Ollantaytambo, that is, the alluvium of the Vilcanota and Patakancha Valleys and the Patakancha alluvial fan. This material is very heterogeneous but is generally recognizable as coming from the local alluvium. Many of the blocks below the temple area have been worked by man, some to perfection, others less so. Seen as a whole, however, most of the blocks and boulders have received relatively little or no treatment before use.

Possibly a very few of the blocks in the sector originated in the Kachiqhata quarries. But this is very uncertain, and it may very well be that actually none of the multitude of blocks are from Kachiqhata. Here, as so often at other archaeological sites at Ollantaytambo, weathering and overgrowth by lichen make the identification of many blocks uncertain. And, of course, destructive sampling with the geological hammer should be avoided.

The trapezoidal settlement of Ollantaytambo

The trapezoidal settlement that makes up the eastern part of present-day Ollantaytambo is considered to have been built during inka rule. Very roughly, it is 300 m by 150 m in size and consists of enclosures with houses, between which streets run more or less at right angles to each other. For a more detailed description of the settlement, see Bengtsson

(in this volume, section 1.3 on "Ollantaytambo and the investigation area").

The enclosures were constructed from stone of different origins and, during a survey along most but not all of the streets, an attempt was made to obtain at least a general overview of the material used. The most important question to be answered by the survey was whether any rock material from the Kachiqhata quarries had been used in the trapezoidal settlement.

As the survey was conducted along the streets only, any difference in the block material between the outsides and the insides of buildings went undetected. The blocks in the walls along the streets can be divided into two types. Relatively large, finely worked or hewn blocks make up the lower parts of the walls. The upper parts of the walls consist of smaller boulders and blocks that often have been only slightly worked.

Very roughly, 70% of the blocks in the lower parts of the walls of the trapezoidal settlement are made up of an assortment of red or reddish-grey, porphyritic, acid, volcanic rock. Some 20% of the blocks consist of several types of acid conglomerates and volcanic breccias. The remaining almost 10% are mainly made up of intermediary, green, volcanic rock. In addition, there is a small percentage of blocks of many different kinds and origins.

Considered very generally, the worked blocks in the sector between the temple area and Manyaraki Square and in the trapezoidal settlement are essentially of the same types, but the percentages are different. In particular, there seem to be more blocks that originated within conglomerates above Manyaraki. The roughly fitted blocks in the upper parts of the walls make up a mixture essentially like that of the rough blocks in the area between the temple and Manyaraki Square, described above.

As far as could be seen, there are no Kachiqhata blocks whatsoever in the trapezoidal settlement. But, of course, the survey covered only part of all the rock material that makes up the stone walls and it cannot be totally ruled out that there are a few blocks from the Kachiqhata quarries scattered in the walls along the streets of the settlement.

Summary

Ollantaytambo in the Vilcanota River Valley in southern Peru is the site of a planned settlement, impressive agricultural terraces and a temple, all of presumed pre-Columbian date. The buildings and walls have been built, using stone from several sources within the region surrounding the village. Here, the investigation is concentrated on the temple, the quarries on the mountain slope of Kachiqhata on the other side of the Vilcanota River, and the transportation route between the quarries and the temple. The object of the geological study, though, is not so much these

sites as the blocks of red granite that were used for building the temple and the blocks that still today lie scattered in the rock-slide areas, along the transportation route and in the temple area itself. To complement the study, the origins and applications of several other types of rock used as building material at Ollantaytambo have been investigated.

With few exceptions, the red, granitic rock of the Kachiqhata mountain slope was found to have been utilised only in the inner temple area of the temple. The outer temple area is almost entirely built up of a dark red, acid tuff or lava of unknown origin. Other investigated ruins, terrace walls, other walls in the vicinity of Ollantaytambo, and the trapezoidal settlement of Ollantaytambo were all constructed using locally available rock. The rock material was taken from bedrock, rock-falls, talus, colluvium and alluvium, often as close as possible to the building site. However, the considerable amount of stone used at Ollantaytambo often forced the builders to collect stone from places well away from the building sites. Still, apart from the rock of the Kachiqhata rock-slides, possibly the blocks in the outer temple area and some other insignificant exceptions, most of the stone used at Ollantaytambo originated from places within a distance of less than a kilometre from the village.

Geological wordlist

This wordlist of geological definitions is far from being a comprehensive geological dictionary. Only the geological terms used in the text and the terms used to explain them have been included. The definitions are not in any way complete, as an attempt has been made to keep the entries short. For a fuller understanding of the terms, and their broader meanings within geology, a comprehensive textbook should be consulted. Apart from a few cases, I have followed *The Penguin Dictionary of Geology* in preparing the wordlist (Whitten with Brooks 1981). Some entries have been followed verbatim, others have been more or less rewritten to suit the purpose of the wordlist. I am alone responsible for any maltreatment of the work of Whitten and Brooks. In the cases in which I have not followed Whitten and Brooks, the definitions indicated in the wordlist are my own or Bengtsson's (in this volume).

Acid rock. An igneous rock with 10% or more of free quartz. Such rocks include those of *granitic*, *granodioritic*, *rhyolitic* and *dacitic* composition.
Agglomerate. A *rock* consisting of angular *rock* fragments of *volcanic* origin, in a surrounding matrix of *rock* (definition by Ahlgren).
Alluvial fan. *Sediments* deposited along a river where there is a decreasing gradient, as where the Patakancha Valley enters the Vilcanota Valley. The fan-shaped accumulation of *sediments* is thickest at the point of decrease in gradient and thins in the downstream direction.

Alluvial plain. An essentially flat area of *alluvial* deposits along the course of a river (definition by Ahlgren).
Alluvium. Material, including *boulders*, *sand* and *silt*, transported by a river and deposited, usually temporarily, along the river.
Andesite. A *fine-grained*, *intermediate*, *volcanic* rock with a chemistry very similar to that of *diorite*. Andesite occurs as large lava flows and is always associated with continental land-masses.
Argillaceous material. The material in a *rock* or *sediment* made up of *clay* or *silt*.
Basalt. A *fine-grained*, *basic*, *igneous rock*, formed when a *basaltic lava* flow solidifies.
Basic rock. A *quartz-free*, *igneous rock*, for example, *basalt*.
Batholith. A term applied to any large *intrusive* mass of *igneous rock*. In almost all cases, *batholiths* are made up of *granite*, in its widest sense.
Block. A piece of *rock* that has been prepared or worked by man (definition by Bengtsson).
Boulder. A piece of *rock* with one side longer than 0.256 metres (see *particle size)* that has not been prepared or worked by man in any way (definition by Ahlgren and Bengtsson). However, during fieldwork, the size definition was not rigorously applied.
Breccia. A *rock* consisting of angular *rock* fragments in a surrounding *rock* matrix. The angularity of the *rock* fragments implies a rather short-distance transport of the material.
Calcite. An often white *mineral* with the chemical composition $CaCO_3$.
Clay. A *sediment* formed by particles smaller than 1/256 millimetres, according to the *Wentworth-Udden scale* of *grain sizes*.
Coarse-grained. This refers to the size of the individual *crystals* in an *igneous rock*. Coarse grains are between 5 and 30 millimetres in size (definition by Ahlgren).
Colluvium. The *colluvium* is formed by *regolith* from the sides of a valley that has been brought down to the river plain by the force of gravity or by the action of water. It has been transported a short distance only, and the *rock* fragments of the *colluvium* are normally angular (definition by Ahlgren).
Conglomerate. A *rock* consisting of rounded fragments of *rock*, suspended in a relatively fine matrix. The roundness of the *rock* fragments implies a rather long-distance transport of the material.
Crystal. An individual grain of a *mineral* (definition by Ahlgren).
Dacite. A *lava* of chemical composition equivalent to that of *granodiorite*.
Diorite. An *intermediate*, *igneous*, *plutonic rock* containing up to 10% *quartz*. It is the *plutonic* equivalent of *andesite*.
Dip. The true *dip* of a plane is the angle it makes with a horizontal plane—the angle being measured in a direction perpendicular to the *strike* plane.

Fine-grained. This refers to the size of the individual *crystals* in an *igneous rock*. Fine grains are less than 1 millimetre in size (definition by Ahlgren). Possibly the term was misused during fieldwork, and some of the *fine-grained* rock referred to in the text may have had grains larger than 1 millimetre.

Granite. An *acid*, *igneous*, *plutonic rock* containing between 20 and 40% of *quartz* and often more than 70% silica.

Granodiorite. An *acid*, *igneous*, *plutonic rock* containing between 20 and 40% of *quartz*. Among other things, it differs from *granite* in having a lower percentage of *silica*. The texture, however, is essentially like that of *granite*.

Greywacke. A *sedimentary rock* that has formed in the ocean. Generally it consists of a poorly sorted *sediment* that may be pebbly. The cementing material is normally *argillaceous*.

Groundmass. The finer-grained material of a *rock*, set between larger units such as large *crystals*, *boulders*, etc.

Igneous rock. One of the three main groups of *rocks*, the two others being *sedimentary* and *metamorphic rocks*. *Igneous rock* has formed from molten *rock* that has solidified on the ground (*volcanic rock*) or below the ground surface (*plutonic rock*). Normally, it takes the form of a mass of interlocking *crystals*.

Intermediary rock. An *igneous rock* with less than 10% of free *quartz*. Such *rocks* include those of *andesitic* and *dioritic* composition.

Intrusion. A body of *igneous rock* that has forced itself into pre-existing *rock*.

Intrusive rock. See *intrusion*.

Joint. A fracture in a *rock* between the sides of which there is no observable relative movement. In a *granitic rock*, *joints* may develop as a result of the unloading of the *rock* when the cover is eroded away. *Joints* may also form as a result of tensional forces during the cooling of a *rock* body.

Lava. A molten or partly molten, more or less fluid material extruded by a *volcano*, which, when solidified, forms a mass of *rock*.

Limestone. The term is applied to any *sedimentary* rock mainly made up of carbonates. Here, it is enough to mention one important carbonate *mineral*, *calcite*($CaCO_3$).

Metamorphic rock. *Rock* altered by the agencies of heat, pressure and chemically active fluids.

Mineral. A *mineral* is formed by the inorganic processes of nature and is made up of *crystals* of specific chemical composition and properties. When applied to *rock*, as here, *mineral* grains of one single type or an assemblage of different *minerals* make up specific types of *rock*. Of course, unconsolidated *sediments* also are made up of grains or composite masses of *minerals* (definition by Ahlgren).

Mineralogy and petrology. The all-including study of *minerals* and *rocks*.
Particle size. In working on *sediments* and *sedimentary rock*, it is necessary to have precise definitions of the sizes of individual particles of *sand*, pebbles, *boulders*, etc. Here, the *Wentworth-Udden scale* of *particle sizes* has been used, as it is widely accepted as an international standard. Size limits for *sand*, *boulders*, etc. have been given under their individual headings.
Phenocryst. Relatively large *crystals* which are set in a *finer-grained groundmass*.
Pillow lava. *Lava* in the form of distorted globular masses which have been extruded under water.
Plutonic rock. A mass of molten *rock* that has solidified below the ground surface.
Porphyritic. See *phenocryst*.
Quartz. A very common *mineral* with the chemical composition SiO_2 It is an important constituent of many types of rock, among which *granite* is very important. Often, *sand* is made up of *quartz* grains.
Quaternary geology. The last 1.7 million years of time. Here, the Holocene, that is, the last 10,000 years, is seen as a division of the Quaternary. The period is characterised by repeated cycles of cold and warm climate respectively. During cold periods, high latitudes and high altitudes are partly covered by extensive ice sheets, ice caps and glaciers. During warm periods, like the Holocene, this ice cover is greatly diminished.
Regolith. The mantle of loose, incoherent, *rock* fragments, from the very small to the very large, that covers the bedrock. As used in this text, *regolith* does not include *alluvium* and *colluvium*. A *regolith* is formed by *weathering* and the mechanical break-up of bedrock (definition by Ahlgren).
Rhyolite. *Volcanic rock* of generally the same chemistry as *plutonic granite*.
River terrace. Marks the position of a former river plain, developed when the river flowed at a higher level.
Rock. Any mass of *mineral* matter, whether consolidated or not, which forms part of the Earth's crust. Here, however, the expression *rock* has been applied to consolidated matter only (definition by Ahlgren).
Sand. For grain-size limits, see *sandstone*.
Sandstone. A group of *sedimentary rocks* in which the particles range in size from 1/16 to 2 millimetres, according to the *Wentworth–Udden scale* of *particle sizes*.
Scree. An accumulation of *rock* fragments formed by the mechanical break-up of *rock*. *Scree* usually forms heaps of debris at the foot of cliffs and steep slopes. The face of the *scree* usually adopts an angle of 25 to 35°. Large particles tend to accumulate at the bottom of the *scree*, while finer particles tend to accumulate higher up on the slope.

Sediment. Unconsolidated material derived from *weathering* and the mechanical break-up of pre-existing *rock*.
Sedimentary rock. *Rock* made up of consolidated *sediments*.
Shale. A *rock* made up of *clay*, that easily breaks up into thin sheets. Unlike *clay*, *shale* does not become plastic when wet.
Silica. An oxide—SiO_2_that is an important component of many minerals, for example, *quartz*.
Silt. Grains between 1/256 and 1/16 millimetres in size, according to the *Wentworth-Udden particle-size* scale.
Spilite. A *basaltic rock* type generally found as *pillow lava*.
Strike. The direction in which a horizontal line can be drawn on a plane. To the geologist, the strike is important in determining the direction in which to measure the true *dip*.
Talus. See *scree*.
Thin section. Most *minerals* are transparent in sufficiently thin slices. Such slices are used to study the *mineral* composition of *rock* samples, using a microscope.
Tuff. Material that has been blown into the atmosphere by *volcanic*, explosive activity. When it has fallen to the ground, the unconsolidated material is called an ash. After consolidation, it is called a *tuff*.
Vesicles. Small cavities in *volcanic lava*, produced by bubbles of gas trapped during the solidification of the *rock*.
Volcanic rock. *Rock* formed by the solidification of eruptive products from a *volcano*.
Volcano. A vent or fissure in the ground, through which molten *rock*, hot gases and other fluids escape.
Weathering. The process by which *rocks* are broken down and decomposed *in situ* by external agencies such as wind, rain, temperature changes, plants and bacteria.
Wentworth—Udden scale. A scale of *particle sizes* widely accepted as an international standard, here used to define the sizes of *boulders*, *sand*, *silt*, etc.
Xenolith. An inclusion of pre-existing *rock* in an *igneous rock*. *Xenoliths* may have suffered partial assimilation by the *igneous rock*.

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GLOSSARY

Words in Quechua are written in different ways in the literature. I have not used any consistent way of spelling in my study. The sources indicated below are Allen (1988) [CA], Bertonio (1984 [1612]) [LB], Cusihuamán (1976) [AC], González (1989 [1608]) [DG], Guaman Poma (1980 [1615]) [FG], Rostworowski (1993*b*) [MR], and Zuidema (1989) [TZ], Place-names are not included in the list, although they often add to the understanding of a site. The words are in Quechua (Q), Spanish (S), Arawak (Ar) and Aymara (Ay).

altiplano (S): high-elevation plain (by Lake Titikaka).
apu (Q): great lord or superior judge or principal leader [DG]; major terrestrial deity, represented by a principal mountain [AC],
aqlla (Q; also **aclla):** religious woman in seclusion, chosen to serve their god, the Sun [DG]; someone chosen.
ayllu (Q): the kind [genus], or species of things [DG]; part or side of a whole, genealogy, lineage or relationship or family [DG]; family grouping or lineage grouping [MR]; family unit linked by a common and mythical origin [MR].
ayni (Ay, Q): recompense or payment in the same kind [DG]; the one who is obliged to work for another, who worked for him [LB]; reciprocal form of labour.
cacique (Ar): provincial leader.
ceja de selva (S): the subtropical-to-tropical, forest zone on the eastern slopes of the Andes.
ceque (Q): line, stripe [DG]; boundary [DG]; sight line marked with shrines.
chicha (Ar): fermented drink, usually made from maize.
ch'ullpa (Ay; also **chulpa):** grave-house, burial tower.
enqa (Q): small stone model, considered the repository of well-being for the animal or household it represents [CA].
hanansaya (Q): upper part, upper moiety.
hatun runa (Q): low man or peasant in *mit'a* or peasant who is not from the town [DG]; low man, peasant or from the countryside [DG].
huaca (Q): holy place; holy object; animal to be sacrificed; superhuman or sacred personage.

hurinsaya (Q; also **urinsaya**, **urinsuyu**): lower part, lower moiety,
inka (Q; also **inca**, **Inka**): name of the kings of this land [DG]; pertaining to the ruling class; nowadays also used to define a period and an empire,
kamayuq (Q; also **camayoc**): someone with a trade or craft or a major-domo who is in charge of property or some field for cultivation [DG]; someone with a special function, knowledge or ability,
kancha (Q; also **cancha**): yard or pen [DG].
khipu (Q; also **quipu**): knot or account kept by knots [DG]; knotted strings, a mnemonic device.
-kuna (Q): plural form of substantives and pronouns.
kuraka (Q; also **curaca**): the lord of the village [DG]; provincial leader.
masca paicha (Q): tassel which was a sign of royalty or the king's crown [DG],
mink'a (Q): the hiring of a person [DG]; reciprocal form of labour,
mit'a (Q): work by shift or turn [DG]; season, time for, shift,
mitmaq (Q): outsider who has moved in and settled down somewhere [DG]; immigrant, re-located person.
moya (Q): orchard or garden [DG]; grassland for feasting belonging to the Inka [FG]; state land.
orejón (S): long-ear (name for the inka nobility, who had their ears pierced and wore ear-spools).
pachak (Q): a hundred.
pachaca (Q): a major majordomo of the Inka who was in charge of his property [DG]; principal serf or brought-up over all the serfs and property and trustworthy. He who guards all that his lord has, or majordomo or provider of supplies or procurator of the property [DG; also see *yana*]; peasant [FG]; *ayllu* [MR].
pampa (Q): flat, flat land [DG]; equable [DG]; common [DG]; affectionate, affable [DG].
panaqa (Q; also **panaca**): descent group in the male line; noble *ayllu*.
parcialidad (S): half of a sociopolitical unit [MR]; synonym of *suyu* [MR],
puna (Q): high-altitude zone, usually with a cold climate [AC],
quebrada (S): ravine, side valley,
qolqa (Q): storehouse [FG].
quechua (Q; also **qheshwa**): land with a mild or warm climate [DG]; ravine or plain valley with a mild or moderate climate, through which usually passes a main river [AC]; today often used for a language,
runa simi (Q): Quechua (the language) [AC].
soq'a (Q): kind of tumour of the body which is attributed to supernatural forces [AC]; malignant supernatural being [AC]; damaging, sometimes fatal, spirit of the ancestors.
suyu (Q): part or side of a whole [DG]; synonym of *parcialidad* [MR]; geographical division [MR]; series of lines or stripes (straight or curved) [AC]; territory comprised within a zonal or regional demarcation [AC].

suyu runa (Q): the taxable vassal [DG].
tambo (Q; also **tampu**): inn [DG]; road station with lodging facilities and storehouses with supplies of clothing, food and arms,
t'oqo (Q; also **toco**): hollow, hole, opening, window [AC],
tupa (Q; also **thupa**, **topa**): something royal, which concerns the King [DG]; honorific title to be used in addressing the King or to be addressed with honour, as we say *Señor* (lord, master) [DG].
usnu (Q; also **ushnu**): judge's court [made] of a stone driven [into the ground], landmark when it consists of a large stone driven [into the ground] [DG]; seat of stone, stone driven [into the ground], the Inka's seat in the litter, land destined to sacrifices [FG in Ludeña 1982]; a seat, and in some cases a platform, associated with a stone, as well as a basin with a drainage system and used for military review, in ritual, and for astronomical observations [TZ],
visita (S): inspection, official inquiry.
yana (Q): "brought-up", servant [DG; his heading is *"yana* or *pachaca"*]; black, dark colour [DG]; someone attached to a leader, household or lineage.
yunga (Q; also **yunka**): plain or valley [DG]; tropical valley, primeval forest, from the tropical valley [AC].

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